[illegible]

[illegible]

Dr Lindley with the Authors Compl:

# WASTE PRODUCTS

AND

# UNDEVELOPED SUBSTANCES:

OR,

## HINTS FOR ENTERPRISE IN NEGLECTED FIELDS.

BY


P. L. SIMMONDS,

DEPUTY-SUPERINTENDENT OF THE COLONIAL DEPARTMENT, INTERNATIONAL EXHIBITION;

*Editor and Proprietor of "The Technologist," Author of "The Commercial Products of the Vegetable Kingdom," "Dictionary of Trade Products," &c. &c.*


"A snapper-up of unconsidered trifles."


LONDON:

ROBERT HARDWICKE, 192, PICCADILLY.

1862.

18660

13606177

TO THE

# COUNCIL OF THE SOCIETY OF ARTS,

BEFORE WHOM THE SUBJECT TREATED OF IN THIS WORK

HAS BEEN FREQUENTLY DISCUSSED,

AND WHO HAVE AWARDED THE AUTHOR THE SOCIETY'S MEDAL

FOR HIS PAPER ON UNDEVELOPED PRODUCTS,

AND MORE RECENTLY ELECTED HIM AN HONORARY LIFE MEMBER

This Work

IS GRATEFULLY DEDICATED

BY THEIR OBLIGED AND OBEDIENT SERVANT,

THE AUTHOR.

# PREFACE.

THE general subject treated of in this volume is one of considerable interest both in an individual and national point of view. It is too extensive, however, in its scope to be discussed successfully in detail here, since any one branch would of itself form a useful and interesting volume. The utilization of waste has been more and more taken up of late years, and has especially occupied the attention of members of the Society of Arts. Indeed, the groundwork of this volume consists of two out of several papers read by myself at evening meetings there,* and of extracts from other papers. Besides those quoted from, I may also direct attention to the communications on Fish Guano, by Mr. Horace Green and Mr. Lawes (Journal of the Society, Vol. II, p. 87); "On the Utilization of the Sewage of Towns" (Vol. V, p. 49); "The Utilization of the Slags of Molten Mineral Products of Smelting Furnaces," by Dr. W. H. Smith (Vol. III, p. 335); "On the Application of Town

* "On some Undeveloped and Unappreciated Articles of Raw Produce from different parts of the World," read Nov. 29, 1854; for which the Society's silver medal was awarded. "On the Utilization of Waste Substances," read Feb. 9, 1859.

Sewage," by Mr. Alderman Mechi (Vol. VIII, p. 261), and others.

I can claim no merit for originality in this work, since I have had to draw largely upon others for supplementary information. My object has been to condense into a brief compass such desultory notes and descriptions as would lead to reflection and investigation, and probably induce many to utilize more generally products now neglected or overlooked. The volume has been passed through the press under very great difficulties owing to my onerous official duties at the International Exhibition, and my numerous literary engagements. Although this can scarcely be pleaded as any legitimate excuse for faults and short-comings, yet it may, at least, be fairly stated in extenuation; for when the work was announced I had anticipated having more leisure for its arrangement and revision. The object in view—the diffusion of practical information on matters too much overlooked.—will, at least, be appreciated, and most probably lead to other works which may supplement the practical information required on many points.

P. L. SIMMONDS.

8, WINCHESTER STREET, S.W.
*June*, 1862.

# CONTENTS.

# WASTE & UNDEVELOPED SUBSTANCES.

THE title of this work scarcely expresses accurately the subject I propose to discuss, but it would be difficult to find one which should embrace and define all the matters to be treated of. There are many substances already utilized, which are to all intents and purposes waste or refuse substances; and there are very many others not used, which are also "waste substances," and well worthy of the attention of practical men. The subject is highly important in its commercial bearings, whether the substances utilized are limited or extensive, because they all lead to a watchfulness and thrift which converts waste matter to some profitable use.

Viewed in its collective form, it has not occupied that prominent degree of attention it demands. Although I cannot hope to bring forward much that is new, yet the hints and details respecting some of these reconversions and applications of waste materials, and the greater development of new products and experiments upon others, may lead to thought, and prove profitable in other quarters, while they will probably elicit much further interesting information on these and like substances.

When we perceive in nature how nothing is wasted, but that every substance is reconverted, and again

made to do duty in a changed and beautified form, we have at least an example to stimulate us in economically applying the waste materials we make, or that lie around us in abundance, ready to be utilized.

In every manufacturing process there is more or less waste of the raw material, which it is the province of others following after the original manufacturer to collect and utilize. This is done now, more or less, in almost every manufacture, but especially in the principal ones of the country—cotton, wool, silk, leather, and iron. But new industries spring up from time to time, and out of the worn substances and waste of these much commercial wealth has yet to be drawn.

The improvements in arts and sciences which are daily taking place, the new manufactures which arise, the increase of population, the extension of colonization, the greater demands hence made upon manufacturers, and the continual waste occurring, are creating urgent wants for new materials of commerce, and a larger supply of old staples than are at present available. So bountiful, however, is nature, that the want has but to be made known, and diligent investigation and inquiry set on foot, and the demand will soon be satisfied.

The student in his library, the scientific chemist in his laboratory, the cultivator in his special field of operations, the botanical and geographical explorer in their travels through distant lands, and the manufacturer in his workshop, testing and proving the value of some new commodity,—each and all of these may and do contribute more or less to the general good of mankind. Every one can lend his aid, therefore, to the general

stock of information—can point out or suggest some pathway to useful discoveries—some unappreciated product, seemingly fitted for a particular purpose, or direct attention to a neglected staple which has not been so generally utilized as it might have been. Nature has yet many materials in her storehouse, awaiting the discovery of man, and fitted for the rapid advancement of civilization and our common comforts. Each one (as I have already observed), in his own range of operations, adds to the general stock of improvement, and discovers something new, calculated to sustain and support man, and to benefit the progress of the world at large.

When we remember how suddenly we were drawn into hostilities with a powerful country, with which we had long maintained peaceful relations, and from whence we had derived valuable supplies of timber, tallow, hides, fibres, and other products of commerce, we should consider the position in which our manufacturers might possibly be placed were a war to arise with the United States, from a stoppage of our supplies of that grand staple of our manufacturing trade —cotton.* In the last fifty years we have paid Russia one hundred and ten millions sterling for flax and hemp alone, exclusive of our purchase of grain, timber, and animal products; and probably we have paid her about six millions sterling per annum. In 1853 we received 41,819 tons of hemp from Russia, and 21,323 tons from other countries; and 64,400 tons of flax from Russia, against 29,770 tons from other parts. Surely, with a little attention and enter-

* The paper of which these remarks form a part was read before the Society of Arts November 29, 1854.

prise, these figures might easily, and speedily, be reversed, and the whole or a greater quantity be obtained from Ireland, Canada, India, and other British possessions. Year by year we are becoming less dependent on Russia.

If we consider the changes of the seat of production in sugar, and the variety of plants furnishing saccharine juices, we cannot say that there is no room for experiment here. For a long period the common sugar-cane was solely depended upon, but some varieties of this plant were soon found to be more productive than others; and countries in which the cane could not, from the nature of the climate, be raised, drew portions of their supplies of sugar from other plants. The sugar maple furnishes the home supply for British America and some parts of the States; the sugar beet yields about 420,000 tons to the Continent. In the East and in Africa, sugar is obtained from the palm tribe. In America it was found that the stalk of the maize furnished a good supply of saccharine juice; and very recently a friend of my own (Mr. Leonard Wray), who has had great experience in sugar planting in the East and West, and has published an excellent work on the cultivation and manufacture of this valuable staple, has patented processes over England, Europe, and America, for producing sugar from another species of grass or cane, the Imphee (*Holcus sp.*), which, from its early maturity and suitability for cultivation in temperate climates, bids fair to work a complete revolution in sugar manufacture.

It is singular to watch the mutations that take place after a few years in the fields of production of

various staples, and the rapidity with which they are transplanted to distant quarters, as local facilities of fresh soil, cheap land, labour, and abundance of capital are found to exist. The West Indies and British Guiana once produced large quantities of cotton, but the production there has almost ceased, and has since been taken up by the planters of the East Indies. The coffee of the West Indies, once a considerable item of production in Jamaica, Trinidad, Cuba, and Demerara, has now been almost monopolised by Ceylon and Java, and the culture has been largely taken up by Brazil. Ceylon now produces more than 30,000 tons. Sugar cultivation is declining in the West, and centring in the East where the little Island of Mauritius produces enormous crops, and the Indian Presidencies and the Straits Settlements are fast increasing their cane plantations. The field of indigo culture has also changed from the West to the East. The geography of commerce is a curious and interesting field of study. Gutta-percha has only come into use about fifteen years, and yet it has become one of the most important products of commerce for the purposes of science and the arts. The extensive trade in cocoa-nut oil, palm oil, and ground nut oil, is but of recent origin. The trade in pine-apples was started but a few years ago ; and even our vast cotton trade from the United States dates but from the close of the eighteenth century, the man being now alive who shipped the first bale to Liverpool, which was reported on as unsaleable, and he was advised to ship no more ; yet the production of this article has risen to three million bales per annum in the United States, and we consume five thousand bales a day in

this country! If by any sudden convulsion our supply of cotton from America should be cut off, how widespread would be the resulting destitution and ruin to many of our merchants and importers, and to a large class of the population in the manufacturing districts. And yet we have every facility of soil and climate for producing, in our own dependencies of Africa, India, and Australia, more than sufficient for our wants.*

Among the incentive rewards offered by the Council of the Society of Arts, at the present time, are premiums—

For an account of the means at present employed in the utilization of so-called "Refuse Products" generally.

For an economical method of rendering the refuse from Scrolls, in making Size, and the waste alkali and filth extracted from Rags in process of boiling, available, each separately, as a Manure.

For the introduction, commercially, of a supply of Hair, for manufacturing purposes, obtained from animals not hitherto resorted to, such as the Musk Ox, &c.

For the largest and best sample of Starch, produced from a non-edible substance, as cheap as any at present in use, and obtainable in large quantities.

---

## COLLECTORS OF, AND DEALERS IN, WASTE SUBSTANCES.

In most large cities there is a class of poor persons who make their livelihood by collecting the offal of the houses, and disposing of it for the purposes of different manufactures. Nowhere is this class so developed as in Paris, where the *chiffonnier* forms a peculiar type, almost unknown elsewhere. It is more

* Since these remarks were originally made the state of things thus hinted at has actually come to pass.

than probable that the reader has never thought of what becomes of the different objects which such persons are seen collecting. Year after year we buy clothes of wool or cotton; we wear them out to a certain point; they then pass into other hands; what becomes of them after? They are not annihilated; they may change their forms; but, nevertheless, the elements of which they are composed do not cease to exist.

Let us examine the ragman's basket: what do we turn up first? We have pieces of cotton and linen rags,—the raw material of the paper-maker, who transforms these unsightly objects probably into the most delicately-scented note-paper. Here, again, we have pieces of paper of all kinds—what can they be for? They form materials for making paste-board, dolls' heads, and occasionally *papier mâché.* What a singular history we have here! The ball-dress of a lady drops into the rag-basket, and reappears as a *billet-doux;* disappears again, to reappear once more in the drawing-room or the nursery, as a workbox or a doll. Returning to the basket again, we find pieces of woollen cloths of different colours,—what use can we put them to, as they do not make paper? The bits of scarlet cloth, which are dyed with cochineal, are boiled in soda to extract the colouring matter, which is used in dyeing chessmen, billiard-balls, and other things. Or we may sort the bits of cloth of different colours, and prepare from them materials for making flock-papers for rooms, or we might make roofing-felt of them.

From the bones rejected from our dinner-tables are

made knife-handles, buttons, and a thousand other articles of a similar character; or we may obtain oil from them, on the one hand, from which soap is made; and, on the other, glue, or the most transparent gelatine, from which ornaments may be made or visiting cards—the residue being burned to make ivory-black for the manufacture of blacking, or phosphorus for the manufacture of lucifer matches. Or we may use it for manure; or as an element in the manufacture of earthenware; and, finally, we may distil the whole bone, and get an ivory-black fit for making sugar white, whilst another substance is at the same time obtained, from which smelling-salts are made. Thus the bones thrown to the dogs in this utilitarian age may come back to us again on our dinner-table, as a part of our dress, as the medium of our politeness, as a means of washing our hands, lighting our fires, and blacking our boots; and, finally, as the contents of that all-important article, a lady's smelling-bottle!

Could the reader have supposed that a ragman's basket supplied the materials for so many manufactures? And yet so it is: modern chemistry has taught us how, out of the most vile and apparently the most worthless rubbish, the most useful and frequently the most beautiful things may be elaborated.*

Rags are the common emblem of poverty, and to say that a man is in a ragged condition is the worst thing that can be said of him; but rags are, in fact, a great source of wealth, and one of the staples of our commerce; for, besides our large home collection, we

* Dublin Exhibition Report.

import cotton and linen rags on the average of years of the value of more than £300,000 sterling; and the whole quantity used in the kingdom exceeds one million sterling. During the war with Russia, there was an enormous demand for linen rags by the apothecaries to scrape into lint. Unless persons, then, have carefully examined the vast amount of the cost of rags, they can form no idea of their great importance.

Our imports of "rags and other materials for making paper" (exclusive of woollen rags), in the last few years, have been as follows:—

| Years. | Quantity. Tons. | Value. £. |
|---|---|---|
| 1854 | 11,415 | 255,910 |
| 1855 | 9,414 | 219,323 |
| 1856 | 10,284 | 230,116 |
| 1857 | 12,196 | 272,848 |
| 1858 | 11,379 | 246,133 |
| 1859 | 14,598 | 323,529 |
| 1860 | 16,122 | 323,044 |
| 1861 | 20,499 | —— |

The sources of supply and comparative prices in 1860 were as follows:—

| | Tons. | Average Price per Ton. £. | s. | d. |
|---|---|---|---|---|
| Russia | 2,238 | 21 | 18 | 9 |
| Prussia | 4,116 | 22 | 4 | 0 |
| Bremen | 233 | 21 | 5 | 0 |
| Hamburg | 3,020 | 22 | 16 | 1 |
| Holland | 235 | 23 | 10 | 0 |
| Tuscany | 924 | 20 | 10 | 0 |
| Papal Territories | 402 | 20 | 10 | 0 |
| Egypt | 2,483 | 12 | 15 | 8 |
| British India | 487 | 15 | 18 | 9 |
| Australia | 530 | 13 | 13 | 0 |
| Other parts | 1,454 | 20 | 2 | 10 |
| | 16,122 | | | |

The itinerant clothesmen of the metropolis are pretty numerous, although I have no precise account of their numbers. In conjunction with the china and glass pedlars, and the vendors of growing plants and flowers, they collect worn-out garments, hats, boots and shoes, &c., which are renovated and made "better than new," either for home sale in Holywell-street, the Minories, and the neighbourhood of the Tower, Monmouth-street, and such localities. Then there are the wardrobe purchasers, whose advertisements are seen continually in the *Times*, requiring garments for export. These classes furnish a considerable portion of the "apparel and slops," to the value of more than £2,000,000 sterling, annually exported, half of which goes to Australia.

The extent of this waste-material trade, if I may so term it, may be estimated by the number of persons engaged in it in London, as gleaned from the pages of the Post-Office Directory. This number, however, is necessarily far below the mark, for it only includes housekeepers, and many in the suburbs are omitted. There are, I find, 354 clothes salesmen (these, perhaps, are not all vendors of *old* clothes, but include some of the outfitters), an undefined number of wardrobe dealers, 160 rag merchants, 564 marine store dealers, nineteen bone dealers (ten of whom are bone boilers), and three bone crushers.

Mr. Mayhew gives the following estimate of the vendors of second-hand articles in the streets of London alone :—

| | |
|---|---|
| Sellers of old metal ware, such as trays, irons, &c. | 90 |
| Sellers of old linen | 30 |
| Sellers of old curtains | 80 |
| Sellers of carpeting | 30 |
| Sellers of old bed-ticking, &c. | 30 |
| Sellers of old crockery and glass | 30 |
| Sellers of old musical instruments | 25 |
| Sellers of second-hand weapons | 6 |
| Sellers of old curiosities | 6 |
| Sellers of telescopes and pocket-glasses | 6 |
| Sellers of other miscellaneous second-hand articles | 40 |
| Sellers of men's second-hand clothes | 100 |
| Sellers of old boots and shoes | 30 |
| Vendors of old hats | 15 |
| Sellers of women's second-hand apparel | 50 |
| Vendors of second-hand bonnets | 30 |
| Sellers of old furs | 10 |
| Sellers of old articles at Islington market | 116 |
| Total | 724 |

Here is a way to get rich, as exemplified in the history of Père Chapellier, *boulanger en vieux.* Chapellier is an old soldier, who, with no fortunc but his services, became a *ravageur.* This is one of the industries of Paris which is rapidly disappearing before the march of modern improvements. A *ravageur* was a man who, when the streets had but onc gutter, and that in the middle of the strect, searched in it for horse-shoe nails, pieces of copper or of brass, &c., which he sold to the dealers in those articlcs. The earnings of a *ravageur*, even the most active, were very small; but with opening carriage-doors at the theatres, and providing a plank at thc crossings, life could bc kept from going out, if not supported. Chapellier sometimes met old comrades while he was thus engaged,

and although he was not proud, an indescribable feeling made him ashamed to be found by them so little above the level of the beggar.

He abandoned this profession and entered the service of a wholesale *chiffonnier* of the Montagne Saint Geneviève ; he became a *trilleur.* The *trilleur* is the person who sorts the contents of the *chiffonniers'* baskets, and arranges them in the warehouse of the wholesale chiffonnier, until the latter can sell them. The pay of a *trilleur* was little more than the earnings of a *ravageur ;* but the former worked in the house, and was not exposed to the chance of meeting an old comrade, although it is true he was exposed for twelve hours a day to a poisoned atmosphere, infinitely viler than that of a dissecting-room. When he met on fête days any of his old acquaintances, and they desired to come and see him, he invariably declined their visit, by saying he was working with a manufacturer who did not allow his hands to receive visitors. But the unhealthy air and sedentary life Chapellier now led made him sick, and he was obliged to go to the hospital.

While in the hospital he made the acquaintance of a *gaveur des pigeons,* who proposed introducing him to his employer, a rich poultry merchant, who took him into his service. His new profession consisted in filling *his* mouth with grain or peas, and ingurgitating them into young pigeons' throats—no easy task, when it is recollected that ordinary *gaveurs* feed two or three hundred pigeons per hour. Chapellier earned forty sous per day at this business : it did not satisfy his ambition, however. Looking around him, he observed

that all the poultry sellers who did not dispose of their stock the day it came to market, were obliged to sell it at so much less each additional day it remained on their hands; and it sometimes happened that they sold at a loss, although the poultry looked, and was as good, as if it had been fresh killed. But no cook could ever be deceived. He inquired into the cause of this mystery; he was told it was simply because the feet, which were brilliant and black the day they were killed, became more gray as that day became more distant. Chapellier revolved this in his head; he made experiments, and at last he invented a varnish which maintained poultry feet for days as brilliant and black as the day of their death. The poultry-women themselves were deceived; the cooks swallowed the deception without the least suspicion. The invention was declared wonderful, and Chapellier received 12½ per cent. on all sales of second day's stock. The profession of painter of poultry feet was very lucrative; but incessant surveillance was necessary, to obtain the 12½ per cent. But Chapellier was ambitious—hadn't he served under the Great Captain, and caught some of his fire? He wanted to be boss of his own establishment; he sold his secret and his customers to a friend for £40. His successor has now retired, and is a man of fortune.

"I wanted to establish myself," says Chapellier; "a thousand professions presented themselves. I could not pass before a shop without envying the happy lot of him I saw behind the counter. I asked every body about their business; at night I formed a plan which I abandoned the next morning. Sometimes I resolved

to be a greengrocer, then *traiteur*, then wine-merchant. But I have too many friends, and was afraid of the credits I should be forced to give. I went to see my old master, the wholesale chiffonnier, intending to go into partnership with him; but, as he asked me £2,000 for that privilege, I was forced to abandon it. He is worth more than £40,000 at least—some say £80,000—which he made in that business. I was in his warehouse when the chiffonniers came in with the results of their rounds. They are always paid cash; there is no credit in that trade, they live on what they get. I was struck by one thing I saw: the quantity of pieces of bread they brought in, and which they could not sell. I questioned them, and ascertained how they got it and what they did with it. An idea struck me; I resolved to establish myself as *boulanger en vieux*, and to sell wholesale what others sold retail."

That very day he bought a donkey and cart; he hired a large room in one of the old colleges so numerous in that quarter, and he went to all the college and school cooks, to propose buying their scraps of bread from them. They had been long accustomed to throw them into the street, and when they heard a man seriously propose to purchase them, they thought him crazy. The success he had with the college cooks encouraged him; he resolved to monopolize the scraps of bread of all the city, so that he need fear no rival. He made bargains with all the chiffonniers, the scullions of all the restaurants, and, as I have said, the cooks of all the schools, colleges, and convents. After all these precautions had been taken, he established

himself one morning at the foot of the fountain of the Innocents, in the very centre of the Halles (the central market). He was surrounded by empty baskets and full bags, and he wore around his hat a large paper placard with this advertisement: "Bread-crusts for Sale." He knew what he was about. He knew that the Parisian likes nothing better than rabbits, and that rabbits require not only a good deal of cabbages, but also a good deal of bread to fit them for market, and that the chickens fed for the Parisian market are fattened on bread-crumbs, to say nothing of the quantity of bread required for the pets of the wealthy, who eschew meat of every description as if they belonged to the family of Grahams, as their master thinks it gives them an unpleasant odour. Chapellier sold his crusts at six sous the basketful, and at this price he soon secured the custom of all the petty rabbit, poultry, &c. feeders of the capital and its immediate vicinity. At the end of a month he saw that he had made a lucky hit. He had doubled his £40, and still he had not given to his commerce all the extension of which it was possible; he could not harvest his bread everywhere in Paris as promptly as he should do; he could go to market but three times a week, and he should go there every morning; he might have employed some one, but there was the danger: his house was not yet sufficiently established, and by divulging his secret he might raise up a dangerous competitor. So he went on slowly, *piano e sano*—four months after his first appearance at the foot of the Fountain of the Innocents, he had three horses and three waggons con-

tinually busy. In a few years Chapellier retired with what he thought fortune enough.

It had always been the castle-in-the-air he founded on, "when I am rich," that he would go into the country and forget Paris. As soon as he considered himself rich, he sold his business and went hundreds of leagues from Paris, to enjoy life. After the first month had dragged its thirty days away, he found himself more miserable than he had ever been in his life before. Before the flowers he had planted grew up, he quitted the country in disgust (like a true Frenchman), and returned to his old haunt on Mont Saint-Hilaire.

In his above-mentioned commerce, Chapellier had necessarily been thrown a great deal with cooks, butchers, and pork-sellers, all of whom are great amateurs of dogs. He ascertained all the secrets of these professions; he learned that all these men used a great deal of bread-crumb for cutlets, *gratin*, &c., &c. Bread-crumbs, made with stale bread, pounded or grated, were sold at eight sous the quart. He established himself *manufacturer of bread-crumbs.* He sold *heaping* quarts at six sous the quart. The cheaper price brought all the customers to him, and in six months he was again obliged to employ workmen, waggons, and horses, to keep pace with his business. He again returned, too, to his old business, buying out his successor, who was going to the dogs, instead of getting the dogs to go to him. He saw that in the bread he received there were two sorts—the good and the bad. He had thought of separating them, but then he found the profit would not compensate the

trouble. He determined to invent a new industry. He made *croûtes au pot.* Stranger, if you ever go to Paris, never order *soupe au pain* or *purée au crouton,* except at the Trois Frères, Café de Paris, or Vefour's. All comes from the *fabrique* of Chapellier—from the *chiffonnier's* basket, the college scrap-basket, the convent's slop-tub. He has established, near the Barrière Saint-Jacques, ovens which never cool, and from whence thousands of pounds of bread are daily poured forth, to be sold as crumbs or crusts. A large number of men, women, and children are busy piling and grating the merchandise as it comes out of the oven. The carbonized pieces and scrapings are pounded, sifted through silk sieves, and sold to the perfumers to make tooth-powder.

Nothing is more curious than the warehouses of le Père Chapellier. They are immense buildings, where mountains of bread are received every minute. Workmen separate these pieces—on the right are those re-destined for man, on the left those destined for rabbits. Wonderful order and cleanliness are everywhere visible. Young girls make up packages of *croûtes au pot,* after weighing them. Children fill large boxes with the black powder. Le Père Chapellier himself is always present among his workmen, scolding, giving orders, laughing, joking—he is a man of genius.

Ask any one, about there, his fortune. "Ah! monsieur!" will be the invariable reply, "notwithstanding *all he spends on gaieties,* he doesn't know how much he is worth."

"About £200 a year, eh?"

"*Allons donc!* That M. Langlois, whose gilded waggons carry about his matches and blacking everywhere in Paris, has £4,000 income from his 4 per cent. stock alone. He gave £4,000 to each of his daughters, in cash, the day they were married. Le Père Chapellier has no children, and his 'profession' is a thousand times better than M. Langlois'."

---

## TEA SUBSTITUTES.

It is said that spent or exhausted tea-leaves are still collected, and re-manufactured, and vended, to a small extent, in London. Mr. Mayhew tells us that, according to information he received, about 1,500 lb. of old tea-leaves were used up weekly in London; and thus 78,000 lb. would be sold annually, by inferior shopkeepers, to the poor Irish and others, blended with cheap genuine tea.

An Act, 17 Geo. III., c. 29, is very stringent in its provisions against this adulteration :—

"Every person, whether a dealer in or seller of tea or not, who shall dye or fabricate any sloe-leaves, liquorice-leaves, or the leaves of tea that has been used, or the leaves of the ash, alder, or other tree, shrub, or plant, in imitation of tea; or who shall mix or colour such leaves with *terra Japonica*, copperas, sugar, molasses, clay, logwood, or other ingredient; or who shall sell, or expose to sale, or have in custody any such adulterations in imitation of tea, shall, for every pound, forfeit, on conviction by the oath of one witness before a justice, £5, or, on non-payment, be committed to the House of Correction for not more than twelve or less than six months."

Section 3 of the same Act also authorizes a magis-

trate, on the oath of any one who suspects that this illicit trade is being carried on, to seize the herbs or spurious tea and the whole apparatus that may be found on the premises. The herbs to be burned, and the other articles to be sold; the proceeds to be shared, after payment of expenses, between the informer and the poor of the parish.

When British leaves are used, they are broken up into a powder and mixed with catechu and gum and a proportion of genuine tea-leaves.

Mr. G. Phillips, the analytical chemist of the Inland Revenue Department, in his evidence before the Parliamentary Committee on Adulteration, stated that the manufacture of adulterated tea was, at one time, a trade in itself; but he had no reason to believe it exists at present.

There were two cargoes of tea wrecked about the year 1840 or 1841; the Treasury granted permission to the underwriters to make the best use they could of it. A party connected with the tea trade washed it and re-dried it on a common kiln used for drying malt. This tea found its way into the market at a reduced price. After the cargo was gone, the trade wanted something to lower the price of their tea, on which the duty then stood at 2s. 1d. the pound, and re-dried tea-leaves were brought up. It became a trade for parties to go round to different hotels and large houses and buy them up at 2d. a pound. The re-dried leaves, however, were not sufficient to furnish the quantity required, and then resort was had to British plants. I believe the manufacture has been entirely suppressed. A patent was taken out some

years ago for the manufacture of British tea, but it was not allowed to be continued. The tea was stopped, and destroyed at the Excise Office. Mr. J. Ingram Travers, in a pamphlet on the tea duties, published a few years ago, remarks:—

"The idea is very general that spent tea-leaves and native hedge-rows contribute some considerable share of ordinary congou; such, however, is not the fact. The collection of the spent leaves of tea in any quantity, to say nothing of their preparation, would involve considerable expense, and, from the extent of individual application required, the intention would be certain of detection. Upon the sloe-leaves attempts have been made, and failed. Some years since, one of the many ingenious contrivers to be found loose upon the world constructed an apparatus, very cleverly managed, to give them the appearance of tea. The hedges within convenient distance furnished the raw material, and, by dint of a moistening warmth and sudden shrivelling blast of hot air, the sloe-leaves, curled up to the dignity of congou, were soon ready for the market. The supply was abundant, the temptation great; there was no law against admixture; any man with a natural desire for fraud might mingle the sloe-leaves with tea to his heart's content, without fear of the Excise. The wholesale merchants, however, took the law in their own hands; a magistrate was found bold enough to issue a warrant for a seizure, on the authority of which the Excise, quite as efficiently as if there had been an Act of Parliament or an Order in Council, broke up the plant, burnt the entire stock, and ruined this home-tea pro-

ducer. The example had its effect : since then there has been no other such attempt. Leaves for admixture have occasionally been cautiously shown in the trade, but they have never taken."

Lie tea is a spurious article made up by the Chinese with a certain proportion of tea-dust, gum, and sand. It is formed into little masses, and afterwards "faced" with turmeric and China clay. The lie tea implies by its name that it is false tea. It contains about 37 or 40 per cent. of earthy matter, and the rest consists of colouring and dust, the sweepings of the floors in which tea has been cured. There was some nominal tea introduced a few years ago from Singapore, in which there was not a particle of tea ; it could not be sold here, and was shipped off to Holland. Samples of it were submitted to Dr. Lindley, and, though he could not identify the leaf, it was neither a British leaf nor a tea-leaf. Some of the common Caper tea from China is very grossly adulterated.

In a paper "On Tea and its Production in various Countries," read by my friend Mr. Leonard Wray at the Society of Arts in January, 1861, he stated that of late years, as the supply of tea has gone on increasing, so has the quality continued to fall off ; until we can at present put but small faith in the purity of nine-tenths of the tea sold in this country. Our millions demand an ever-increasing quantity of cheap tea, and accordingly an article is made up and sold to them at an apparently low price. But what do the buyers actually obtain for their money ? It is the semblance of tea, but not the reality,—a veritable delusion and imposture.

The adulteration carried on by the Chinese of late years is greatly increasing: old and common leaf is incorporated with the new and fine. Most of it is re-fired and re-manipulated. The adulteration may be described as of two classes—the positively spurious, and the sophisticated. The former is known in the trade as Tayshan congou; it also represents most of the Pekoes, Capers, and Canton greens. In their manufacture is employed exhausted leaf, also leaves from three plants,—*Gynura auriculata*, *Ardisia crispa*, and a common species of mint. The spurious teas are mostly from Canton and its locality, and their quality, for the most part, is execrable. The sophisticated teas are from Foochoo-foo, and for purity they rank higher than the former.

To use the words of Mr. Wray, "What with the 'lie' tea of China and the 'lie' tea of England, many begin to regard the tea of our shops as being a huge *lie* altogether. For myself, I cling to the comforting assurance that the Chinese do sell us one-eighth of the whole quantity of tea consumed, or 10,000.000 lb., unadulterated, and I try to believe that this is not tampered with in any way, but comes to us pure and wholesome. Who is it, then, that suffers from these double frauds? It is the million. And the lower the class, the greater are the impositions we see practised upon them; until we cannot but repeat that exclamation, which in very bitterness of spirit a good and tender-hearted man gave vent to, 'God help the poor!'"

Mr. W. G. Reynolds, a practical judge of the qualities of teas, from many hundred samples passing

through his hands daily, however, emphatically asserts, in contradiction, that the great bulk of the tea imported into this country during the last ten years has been unadulterated. Imports of spurious tea had been tried; but this description of adulteration had long since ceased, because there was no market for such an article. These imitation teas consisted of such rubbish as may become mixed with the sweepings of the Canton packing warehouses, certain and sundry teas damaged during land or junk transit in China, &c., together with such odds and ends as accumulate from time to time at the said port, and are then broken down by mills into dust, rolled into large shot-like particles by means of a preparation of gum or starch, and coloured and scented as either Canton gunpowders or capers; but these occasional adaptations and imitations, however, only serve to prove the result of a false economy, wrongly based on the maxim of gathering up the fragments; since such consignments have seldom if ever paid, when brought here, the bare expenses of manufacture and transit. The same has been the ultimate fate of all other grades, of whatever kinds, which have really been of the class of spurious sorts, as on such parcels, even when they have sold at a profit on first arrival, profit has never resulted to the purchaser, but invariably a fearful loss. No sort of leaf is so abundant in the tea districts of China as the leaf of the genuine tea-plant; and as any other leaf (even here, where the means of manufacture are at hand) would entail as much, or more, trouble and expense in the gathering and preparation, where or in what can exist the motive for substitution? I alto-

gether pass over the absurd supposition that tea-leaves already infused are collected and re-dried; the process of collection, purification from consequent mustiness, &c., and re-manipulation, would be more difficult and expensive than the preparation and first cost in China of the finest crop of tea ever produced. For these simple reasons I would, therefore, humbly submit that teas as imported are not open to the charge or suspicion of having been largely adulterated.*

In a case of embezzlement, lately submitted to the Paris Tribunal of Correctional Police, a curious disclosure was made, namely, that there exists at La Villette an establishment which effects the "revification" of coffee-grounds, and after mixing them with a small portion of pure coffee and other substances, sells them as coffee. Nay, more, that the "revivified" coffee-grounds, after being used, are subjected to a new process of "revivification," being again mixed with other substances, and once more sold as pure coffee.

The employment of the leaves, berries, and roots of plants may be considered to be one of the very first resorts of mankind to appease those pangs of hunger which often press so heavily upon poor humanity, when existing in its most primitive state. Hence we find that those barbarous savages who are existing in the most primitive condition possess a seemingly instinctive knowledge of the alimentary value of the herbs whereby they are surrounded, and to which they are so frequently compelled to have recourse in order to sustain their very lives.

* Journal of Society of Arts, vol. ix. p. 182.

The leaves of the *Glaphyria nitida*, called by the Malays the "Tree of long life" (Kayo umur panjang) —probably from its maintaining itself at elevations where the other denizens of the forest have ceased to exist—afford, at Bencoolen, a substitute for tea, and it is known to the natives by the name of the Tea-plant.

Various species of Leptospermum and Melaleuca bear the same name in the Australasian colonies. The leaves of *Smilax glycyphylla*, a native of Australia, have a sweet taste, and are used in infusion under the name of Sweet Tea.

The Kawa-kawa, or Pepper-tree, a kind of cane, is used as tea in New Zealand; and so are the leaves of the dwarf Manuka, or Tea-tree.

The settlers of New Holland employ the leaves of Corræas for tea, especially of *C. alba*.

The bark of the Australian Sassafras-tree has already obtained some celebrity as a substitute for tea.

*Bæckea utilis* (F. Mueller), from Mount Aberdeen, in Victoria, might serve travellers in those desolate localities as tea; for the volatile oil of its leaves resembles greatly in taste and odour that of lemons, not without a pleasant, peculiar aroma.

The leaves of some species of Cyclopia, a plant of the leguminous order, are used in the Cape Colony, under the name of Bush-tea and Honey-tea, by the Dutch Boers. The leaves have an agreeably fragrant tea-like odour. Those of *Printzia aromatica* are also used by the settlers.

Nicholas, in his "Voyage to New Zealand," states,

"There is here a species of the myrtle similar to that found in various parts of New South Wales. Another species of it grows in the country about Dusky Bay, an infusion of which was drunk by the crew of the *Endeavour* as a substitute for tea. The leaves of this shrub have a pleasant aromatic flavour at the first infusion, but yield a strong bitter when the water is poured on them a second time. Besides being aromatic, they have the same astringent properties as tea, and they were generally used instead of that plant by all the ship's company of the *Resolution*, who were supposed to have derived the most salutary effects from it towards the restoration of their health, which was very much impaired on their arrival in these regions."

The poorer natives of China substitute the leaves of a species of Rhamnus, or Fallopia, which they dry; Camellia leaves are, perhaps, mixed with it, but probably to no great extent.

The coarsest leaves of the tea-plant are beaten into cakes, and exported principally to Tartary under the name of "kaiel-cha," or brick-tea.

The leaves of *Hydrangea Thunbergii* are dried in Japan, and used as a kind of tea, which, for its excellence, they call "ama-tsja," or tea of heaven. Another sort of tea is furnished by *Platycrater arguta*.

The leaves of *Verbascum Phœnicium*, according to Pallas, are used in Siberia as a substitute for tea; and the dried leaves of *Bouchea pseudo-gervao*, in Brazil, in the same way as *Stachytarpheta Jamaicensis*, a small shrub, growing in South America. The leaves of *S. mutabilis* are sold in Austria under the

name of Brazilian tea. The aromatic leaves of *Lantana pseudo-thea* are highly esteemed as infusion in Brazil, where it is vulgarly called "capitao do matto," or "cha de pedresta." Auguste de St. Hilaire speaks in high terms of praise of the agreeable properties of this tea substitute.

In New Brunswick, Labrador tea, chocolate-root, and other native plants, yield, by decoction, wholesome and pleasant beverages.

The leaves of the American Redroot, or New Jersey tea (*Ceanothus Americanus*, Lin.), dried, were used by the Americans as a substitute for Chinese tea during the War of Independence. This shrub ranges from Maine, Michigan, and Wisconsin, to Canada West. The *Prinos glaber*, an evergreen North American bush, is employed as a substitute for tea.

An infusion of the leaves and flowering tops of the Lapland rosebay (*Rhododendron Lapponicum*) was drunk by Dr. Richardson and other Arctic travellers, instead of tea; but it makes a less grateful beverage than the narrow-leaved Labrador tea (*Ledum palustre*), the "medicine leaves" of the Cree Indians. This shrub is an inhabitant of the colder parts of Canada, the coasts of Newfoundland and Labrador, and the whole of Rupert's Land, to the Arctic Sea. Another species (*L. latifolium*), also used for tea in Vancouver, extends farther south, being common in cold boggy grounds in the Northern States of America.

Dr. Barton states that during the American Revolution, when Chinese tea was scarce or not procurable, it was a common practice to make tea of the recent or dried leaves of the creeping winter-green (*Gaultheria*

*procumbens*); and after being sweetened with sugar and softened with milk or cream, it was drunk by many families at breakfast and supper in lieu of common tea or coffee. It makes a very pleasant and soothing drink in nervous fevers, and is useful in asthma. This fragrant shrub, known as the chequer-berry, partridge-berry, and box-berry, is a great ornament of the woods north of Lake Superior. It inhabits most woods in the Northern States; grows at Pictou, Nova Scotia, and on Lakes Huron and Superior; and was traced by Dr. Richardson northwards to the Lake of the Woods, or near the 50th parallel. The succulent fruits are sometimes used as food.

An infusion of the leaves of Te (*Corchorus siliquosus*, Lin.) is drunk on the Isthmus of Panama instead of tea; and a similar preparation may be made from those of the *Freziera thæoides* (Swartz), a shrub common on the volcano of Chiriqui.

Under the name of West India tea, the leaves of the shrubby goatweed (*Capraria biflora*) are occasonally used for infusing in the Antilles. According to Long and Barham, the leaves not only resemble those of tea, but make an equally agreeable decoction, which is also recommended as an excellent febrifuge. This plant is very common everywhere in the Savannas, and about the towns of Jamaica. What Barham says of it may not be thought unentertaining. "A Frenchman, captain of a ship, affirmed to me, as we were walking about our town of St. Jago de la Vega, and observing this plant growing so plentifully, that it was the same as the tea-plant of China; that

he had lived in that part of the world many years; had seen large fields of it, and the manner of cultivating it; and all the difference was, that the Chinese plant was larger, which he ascribed to their care and culture of it; and had no doubt but the Jamaica plant, if it was set in rich ground, and attended with equal care, would improve in size. They are, however, very different plants. Barham mentions a gentleman who never drank any other than the West India tea; and that, although he could not coil up the leaves so dexterously as they do in China, yet he performed this operation tolerably well; and the persons whom he regaled with it extolled it as the very best green tea they ever drank in their lives. It is certainly unknown to what perfection it might be brought, if reclaimed from its wild state and cultivated in the rich soil of gardens, and it well deserves the experiments of the curious."

An infusion of the fruit of *Elæodendron orientale* is drunk by the Burmese as tea. The leaves of the *Grislea tomentosa* are used for tea by the hill tribes near Ellichpoor, where the shrub grows.

Dr. Hooker mentions that in Sikkim the leaves of *Photinia* (a plant allied to hawthorn), Gaultheria, Andromeda, Vaccinium, and other allied plants, are used by the natives for making tea.

In Iceland the natives prepare a tea from *Achillea millefolium*, which is said to be good for purifying the blood. In Newfoundland, an undefined plant, named "Wisha capuca," is used to make tea by the Indians. In Finland they make an infusion from the leaves of the birch.

Dr. Hassall states that the leaves of the following British plants have been detected from time to time in samples of tea of British fabrication :—Beech, elm, horse-chestnut, sycamore, plane, bastard-plane, bay-leaves, fancy-oak, willow, poplar, hawthorn, and sloe. The leaves, separate or mixed, of speedwell, germander, black-currant, mock-orange, purple spiked willow-herb, sweet-briar, cherry-tree, and bramble, have been substituted by dealers in America.

What is called Russian tea consists of the leaves of saxifrage, winter-green, white virgin's bower, bird-cherry, dropworts, common elm, male-fern, and dog-rose. The roasted leaves of lemon-grass (*Andropogon schœnanthus*) are used in India in infusion as an excellent stomachic. *Aspidium fragrans* has also been used as a substitute for tea.

A French chemist has discovered that oak-leaves make excellent tea ; and a Vienna doctor (M. Kletznisky) maintains that strawberry-leaves, after being dried either in the sun or on hot metal-plates, make a drink which is an excellent dietetic, of an agreeable odour and astringent taste, like China tea. After distillation, whereby a very pleasing scent is obtained, the residue gives tannin, citric acid, and a small quantity of some nitrogenized substance. *Xenopoma theasinense* has been cultivated in France as a tea substitute.

In France, the quantity of tea consumed is insignificant, and its price per pound for good qualities varies from 6s. to 10s. The inhabitants drink wine instead, but a large portion is watered, and a still larger is adulterated; while whole districts drink

nothing but compositions and imitations. The librarian of the town of Cahors—a personage half botanist, half savant—having discovered, in November last, a native plant which furnished an infusion resembling exactly in colour, aroma, and taste, the infusion of black China tea, came to Paris, and wrote thus to the Emperor :—"Sire : Napoleon I. endowed France with an indigenous sugar; your Majesty may now endow the country with an indigenous tea." Two days afterwards, one of the officers of the household invited M. Perrie, the botanist, to call and see him; he tasted the tea, and then conducted him to the Ministry of Agriculture. A committee of examination was appointed; and M. Perrie, on his return to Cahors, sent them a package of his dried wild herbs. The committee spent several months in its investigation, and has but lately made its report. The Minister of Agriculture has just written to M. Perrie, that, besides the qualities of taste, smell, and colour, which are those of the best China teas, the new infusion is tonic and slightly astringent. The grand question of price, he added, is all that requires to be elucidated. The botanist replies, that the plant is a common and, thus far, unserviceable weed, and that, even if cultivated, it may be produced at the price of *twenty cents a pound.* The *Presse* is delighted with this discovery, and with the prospects it affords the poor. But if it is to be considered a boon in a country where the taste for it has still to be created, and where even a prejudice exists against it, of how much greater value will it be to countries where the taste is already formed, and where the annual tea bill is counted by

millions of pounds sterling? One pound of the weed yields *five hundred cups,* and requires two minutes for its preparation ; so that French tea is not only much cheaper than Chinese, but it goes four or five times as far.

Under the name of Bois Dine, the fruit of a species of Myrtus (probably *M. ligustrina,* of Swartz, or *M. cerastina,* of Vahl) is used by the Dominicans of Hayti to prepare a sort of tea.

The little tea-plant (*Myrtus nummularia*), a species nearly allied to the classic myrtle, is commonly used at the Falkland Islands as a substitute for the Chinese herb, to which many of the Guachos prefer it. Singularly enough, the first settlers of New Holland and Van Diemen's Land selected a shrub of the same natural order (a widely different one from that to which the true tea belongs), and brewed tea from it to a great extent. The plant is also said to be diuretic, and might prove useful in medicine ; for this purpose the young leaves should be gathered and dried separately, or, rather, scattered on sheets of paper and exposed to the sun or a moderate fire, after which they should be kept free from damp.

The leaves of *Lycium barbarum,* known in Northern Africa as tea-plant, have been recommended as a substitute for the Chinese plant. The *Cistus albidus,* the wild tea, and other plants of Algeria, are also used as substitutes by the natives.

*Elichrysum nudifolium,* under the name of Kaffir tea, and *E. serpyllifolium,* Less., Hottentots' tea, are used for making an infusion in South Africa.

The leaves of the striped-flowered psoralea (*Psoralea glandulosa*), known under the name of culen, are, according to the Abbé Molina, considered as a powerful vermifuge, and one of the best stomachics. They are used as an infusion, and their aromatic flavour causes them to be preferred by some persons to tea, for which they may be substituted. In Chili they are so used, instead of the Chinese beverage, under the name of Jesuits' tea. The culen has lately acquired a great reputation in the Mauritius as a medicinal substance.

It is drunk as an infusion in the shape of tea; and is, according to those who have been under the necessity of taking it, a sovereign remedy in asthma, oppressions of the chest, and other irritations of the bronchiæ and lungs, which it relieves and dispels almost instantaneously. The leaves are also used dried, and afterwards smoked like tobacco. Faham or *Faam*, an orchidaceous plant (*Angræcum fragrans*), is found in the interior of the island of Mauritius. Virey wrote about the faham, in 1820 and 1826, in the *Journal de Pharmacie;* and Dr. Giraudy, who studied it seriously, discovered, in the aromatic principle of this plant, a diffusible stimulant capable of deadening nervous sensibility; in the bitter principle, an excellent stimulant to revive the strength of the nutritive organs; and in the mucilage, a demulcent to relax the tissues. He, therefore, considered it as a powerful medicinal agent, and likely to be employed with success either to assist digestion, to soothe coughs and pains of the chest, to remove spasms and oppressions, or to promote expectoration in colds, hooping-

coughs, fits of asthma, and pulmonary phthisis, whenever the nervous irritation and inflammation predominate. The odour of the dried plant is peculiar, and resembles that of the Tonquin bean; the infusion or syrup is very pleasant. It has been used, in infusion, as a beverage, in substitution for Chinese tea.

The late Professor Johnston, in his "Chemistry of Common Life," collected a few notes upon tea substitutes; but the list he published was very imperfect, and did not include more than about thirty species of plants stated to be so used. The following list will be found to be much more complete, embracing, as it does, more than three times that number :—

## LIST OF SUBSTITUTES FOR CHINA TEA.

(UNLESS WHERE OTHERWISE STATED, THE LEAVES ARE USED.)

| *Local Names.* | *Names of Plants.* | *Where collected and used.* |
|---|---|---|
| Paraguay Tea, or Maté | Ilex Paraguayensis | Paraguay. |
| ,, | Ilex Gongonha | Brazil. |
| ,, | Ilex theezans | ,, |
| South Sea Tea | Ilex vomitoria | N. A. Indians. |
| Appalachian Tea | Prinos glaber | North America. |
| ,, | Viburnum cassinoides | ,, |
| Oswego Tea | Monarda didyma | ,, |
| ,, | ,, purpurea | ,, |
| ,, | ,, Kalmiana | ,, |
| | Lycium barbarum | Barbary. |
| | Cistus albidus | Alger a. |
| New Jersey Tea | Ceanothus Americanus | North America. |
| | Symplocos Alstonia | New Granada. |
| | Alstonia theaformis | ,, |
| West-Indian Tea | Capraria biflora | Central America. |
| Jesuits' Tea | Psoralea glandulosa | Chili. |
| ,, | ,, dentata | ,, |
| | Myrtus ugni | ,, |
| | Cremanium theezans | Peru. |
| | Bouchea pseudo-gervao | Brazil. |
| Brazilian Tea | Stachytarpheta Jamaicensis | S. America. |
| ,, | ,, mutabilis | ,, |
| | Meriana rosea (Flowers) | Jamaica. |
| Port au Paix Tea | Croton Cascarilla (bark) | St. Domingo. |
| Toolsie Tea | Ocymum album | N. America & India. |
| | ,, cristatum | Java and Japan. |

| *Local Names.* | *Names of Plants.* | *Where collected and used.* |
|---|---|---|
| Mountain Tea | Gaultheria procumbens | North America. |
| | Viburnum prunifolium | ,, |
| | ,, lævigatum | ,, |
| Mexican Tea | Chenopodium ambrosioides | Mexico and France. |
| Labrador Tea | Ledum palustre | North America. |
| ,, | ,, latifolium | Vancouver. |
| Amazons' Tea | Eupatorium ayapana. L. | South America. |
| Chinese | Segeretia theezans | ,, |
| ,, | Camellia Japonica | China. |
| ,, | ,, drupifera | ,, |
| ,, | ,, Sasanqua | ,, |
| ,, | Olea fragrans (flowers) | ,, |
| ,, | Teucrium thea | Cochin China. |
| ,, | Lantana pseudo-thea | Japan. |
| ,, | Hydrangea Thunbergii | ,, |
| Kunaar, or Rhocha | Osyris Nepalensis | Nepaul. |
| Lemon Grass Tea | Andropogon Schœnanthus | W. Indies & Ceylon. |
| | Myricaria herbacea | Monguls. |
| | Rhododendron chrysanthum | Tartars & Kirgues. |
| | R. Lapponicum | Arctic America. |
| | Eugenia pimento | Jamaica. |
| | Beatsonia portulacifolia | St. Helena. |
| Faham Tea, or Bourbon Tea | Angræcum fragrans | Mauritius. |
| | Myrtus numularia | Falkland Islands. |
| Yapon | Ilex Cassine | South Seas. |
| | Pediculans lanata | Europe. |
| Bencoolen Tea | Glaphyria nitida | East Archipelago. |
| Tasmanian Tea | Corræa alba | Van Diemen's Land. |
| New Zealand Tea | Acæna Sanguisorbæ | New Holland. |
| Sassafras Tea | Atherosperma moschata (bark) | Tasmania. |
| White Tea Tree | Melaleuca genistifolia | Australia. |
| | ,, scoparia | ,, |
| | Bæckia utilis | ,, |
| | Leptospermum thea | New Holland. |
| New Zealand Tea Tree | ,, scoparium | ,, |
| Sweet Tea | Smilax glycyphylla | ,, |
| ,, | ,, ripogonum | ,, |
| Kaffir Tea | Helichrysum nudifolium | Cape Colony. |
| Hottentots' Tea | ,, serpyllifolium | ,, |
| ,, | ,, auriculatum | ,, |
| ,, | Printzia aromatica | ,, |
| Bush Tea | Cyclopia latifolia | ,, |
| Honnig-thee | ,, genistoides | ,, |
| Khat | Catha edulis | Abyssinia & Natal. |
| | Verbascum phœnicium | Siberia. |
| French Tea | Xenopoma thea-sinensis | France. |
| | Photinia, &c. | Sikkim. |
| | Grislea tomentosa' | Northern India. |
| | Freziera thæoides | Central America. |
| | Corchorus siliquosus | ,, |
| Thé de Simon Pauli | Myrica gale | |
| Coffee-leaf Tea | Coffea Arabica | Sumatra. |
| | Aspidium fragrans | Siberia. |
| Russian Tea | Saxifraga sp , Gaultheria, &c. | Russia. |
| Lemon-scented Verbena | Lippia citriodora | Mexico. |
| Swiss Tea | Ptarmica nana | Swiss Alps. |
| ,, | ,, atrata | ,, |
| ,, | ,, moschata | ,, |

| *Local Names.* | *Names of Plants.* | *Where collected and used.* |
|---|---|---|
| Thé de l'Europe | Veronica officinalis | Europe. |
| ,, | ,, chamœdrys | ,, |
| Sloe Leaves | Prunus spinosa | ,, |
| Strawberry Leaves | Fragaria collina | ,, |
| ,, | ,, vesca | ,, |
| Sage Tea | Salvia officinalis | ,, |
| Marjoram Tea | Origanum vulgare | ,, |
| Norwegian | Rubus arcticus | Norway. |
| Willow Herb | Epilobium angustifolium | Britain. |
| Black Currant | Ribes nigrum | ,, |
| White Thorn | Cratægus oxycantha | ,, |
| Bird Cherry | Cerasus avium | ,, |
| Cornelian Cherry | Cornus mas | Central Europe. |
| Sassafras | Sassafras officinale (chips) | Europe. |

---

## NEW EDIBLE ROOTS.

It is surprising how little we have experimentalised in this country upon new edible roots, which might come in as useful aids to the potato for food purposes. But two or three attempts are all that I can call to mind; and yet the field of research is a wide and a promising one, especially now that our trade with foreign countries and quick steam navigation place so many tuberous-rooted plants within our reach for trial and cultivation. The attempt to introduce some edible root that might prove suitable to our climate, and become enlarged by cultivation, is surely a patriotic one, and within the means of any enterprising cultivator who may choose to give himself to the task.

The introduction and success of the common potato is an example worth following. Two centuries and a half ago this root was recommended by old Gerarde, in his "Herbal," to be eaten as a "delicate dish," but

not as a common food; and within little more than a century its culture has been so extended over the United Kingdom, Europe, and America, that it has not only become a *common* food, but the various economic uses to which it is applied are almost infinite. And yet, if we trace it to Chili and Peru, we shall find that in its indigenous condition it bears but a poor resemblance to the magnificent tubers resulting from continued careful cultivation.

Protracted nursing has alone produced such effects on wild vegetable productions as to render them our commonly cultivated plants. The large and juicy Altringham carrot is only the woody spinal root of the wild carrot, luxuriously fed. Our cabbages, cauliflowers, kohl-rabis, and turnips in all their varieties, spring from one or more species of *Brassica*, which in their natural state have poor woody bitter stems and leaves, and useless spindle-shaped roots. Our cultivated potato, with all its varieties, comes from the tiny and bitter root of the wild potato, which has its native home on the sea-shores of Chili; and our apples, plums, grapes, strawberries, and other prized fruits, from well-known wild and little-esteemed progenitors. Our gardens are full of such vegetable transformations. It is so also with our corn plants.

It is the new chemical conditions in which the plants are placed which cause the more abundant introduction of certain forms of food into their circulation; and the more full development, in consequence, either of the whole plant or of some of its more useful parts. It has been well observed that if a new plant has a chance of becoming useful in rural

economy, it must fulfil certain conditions, in the absence of which its cultivation cannot be profitable. In the first place, it must have been domesticated in some measure, and must suit the climate; moreover, it must in a few months go through all the stages of development, so as not to interfere with the ordinary and regular course of cropping; and, finally, its produce must have a market value in one form or another. If the plant is intended for the good of man, it is also indispensable that it shall not offend the tastes or the culinary habits of the persons among whom it is introduced. To this may be added, that almost all the old perennial plants of the kitchen-garden have been abandoned in favour of annuals, wherever the latter could be found with similar properties. Thus *Lathyrus tuberosus*, *Sedum telephium*, &c., have given way before potatoes, spinach, and the like.

Let us glance at some of the roots and tubers eaten in different countries which are worth notice. We need not specify the sweet potato, the cassava or mandioc root, the yam, and other tropical tubers which can scarcely be acclimatised here; although some may be so modified (as we have seen in the Chinese yam) as to be raised with care here. It is a curious investigation to run over the different roots that are eaten as food by various tribes and people, many of which would not be very acceptable to the dainty palates of Englishmen. Very few of the coarse fibrous yams, for instance, would find favour with those accustomed to the mealy potato. The root of the common carraway plant, when improved by culture, resembles

the parsnip, and is used as food by the inhabitants of the North of Europe.

Many of the water-plantain tribe have a fleshy rooting stem, which is eatable. At the root-stock of the arrowhead (*Sagittaria sagittifolia*) there is a tuber composed almost entirely of starch. Martius compares the fecula of these tubercles to arrowroot. The Kalmucks, the Chinese, and the Japanese eat them as articles of wholesome food. By the two latter the plant is cultivated for these tubercles. From the bulbous roots of the cacomite, a species of *Tigridia*, a good flour is prepared in Mexico.

The roots of several species of *Caladium* are nutritious, and furnish an abundance of food. The very large roots of *C. esculentum* and *C. arborescens* especially furnish a great quantity of fecula. Several species of *Arum* (the same family which furnishes the indigenous Portland arrowroot, formerly held in some repute) are eaten in different countries. *A. indicum* is much cultivated in Brazil, about the huts of the natives, for its esculent stem and pendulous tuber. The roots of *Arisarum vulgare* are boiled and eaten in the South of Europe. *Amorphophallus campanulatus* is extensively cultivated in the Northern Circars, India, for its roots, which are highly nutritious, and the longer ones will weigh from 4 to 8 lb. The roots of *Colocasia macrorhizon*, a native of the Moluccas and the South Sea Islands, are very large; and when washed to deprive them of their acrid principle, are eaten in Tahiti. *Colocasia esculenta* grows in Spain, Portugal, Sardinia, and particularly in Egypt, where it has been

cultivated from time immemorial for its roots, which serve as an article of food. They contain an immense quantity of fecula, and are eaten by the inhabitants of Egypt and some parts of India, forming the principal food of the inhabitants; their flavour is like that of potatoes. The roots of *C. himalensis* form the principal part of the food of the hill people of the Himalayas. The bay root, which grows about the out-islands of the Bahamas group, was found of great use as a food plant to the inhabitants of Long Island during a scarcity of food occasioned by the drought of 1843. The root grows in the form of a large beet, and is from twelve to sixteen inches in length. It is entirely farinaceous, and when properly ground and prepared makes excellent bread. The bulbous roots of *Ornithogalum umbellatum* have been commonly eaten in Italy, in Syria, and the neighbouring countries. Dioscorides says that it was sometimes dried, pulverised, and mixed with corn flour; and that it was also eaten both raw and washed. Lamertens, in his "Essay on Bulbous and Tuberous Roots," states that in his time the peasants of Italy and the neighbouring countries often roasted the roots of the *Ornithogalum*, and ate them like chestnuts, or lightly boiled them, and peeled and used them as salad, with oil, vinegar, and pepper.

The French have been much more zealous than we have in this inquiry for new edible roots. Among others brought under the notice of the Academy of Sciences have been the bulbous-rooted cicely (*Chærophyllum bulbosum*), a European plant of the most

easy culture, which will grow in any soil. It yields an abundance of tubers about an ounce each, very wholesome, containing 21 per cent. of starch. The turnip-formed tubers, when taken up early in the spring, are eaten in France and Germany, boiled with oil and vinegar. The roots only contain 63 per cent. of water, while the potato consists of 74 per cent. and more. We are not told, however, whether the root can be presented at table in its native form, like the potato, or without any other cooking than simple boiling. Comparative analyses made by M. Payen show that it contains less water, more starch, albumen, and other nitrogenous substances than the potato, and a small proportion of cane sugar. Another plant brought under the notice of the Academy (introduced from New Granada, under its native name of Shicarra only), has white, juicy, and sweet tubers, that can be eaten raw. It is an annual shrub, growing to the height of about three feet, and as it stands cold well, it is thought it might prove a rival to the beet-root in Europe, being richer in sugar.

The roots of *Apios tuberosa* are eatable, and are sold in some of the German markets. Professor Eaton, in his " Manual of Botany for North America," remarks that this nutritive root ought to be generally cultivated. The tubers are, however, not larger than cherries, but very farinaceous, with a large per-centage of starch. The roots of *Claytonia tuberosa* are eaten in eastern Siberia ; and an American species, *C. acutiflora*, has been recommended for experimental culture here. The tuberous roots of *Bunium bulbocastanum* in Europe,

like those of our British species, *B. denudatum*, contain well-known nutritious qualities. When boiled they are very sweet and delicious. In Holland, the Alps, and in some parts of England, they are used in soup, and also roasted under the embers, when they eat like roasted chestnuts. The tubers of *B. ferulaceum* are used the same way in Greece. The Apios (*Arracacha esculenta*), a perennial, is extensively cultivated for culinary purposes in the temperate mountain regions about Santa Fe de Bogota. The large roots are cooked and eaten like parsnips, but considered better and easier of digestion. It has been introduced into the South of Europe. A very promising tuber seemed to be the Ocas of South America (various species of *Oxalis*), but they have not been persevered in long enough to ascertain whether the roots could be enlarged by continued culture. *O. crenata* was introduced a few years ago from Peru, as an object of cultivation in this country for its tubers. These, however, are rarely more than two ounces in weight; and although they are of a mealy consistency, and by some considered, if not equal to, at least a good substitute for, the potato, it has not been found profitable to devote any attention to their culture as an esculent, since the average produce of a plant did not exceed half a pound. Hence the experiment was dropped. *O. tuberosa* is extensively cultivated in Bolivia for its numerous tubers, which are like small potatoes, and about an inch in diameter. They have a slightly acid flavour, which is disagreeable to most persons; this is lost by exposing them to the sun, the acidity being thus converted into saccharine matter, and the tubers become

as floury as the best varieties of potatoes. The tubers are exposed in Bolivia for ten days in woollen bags, which appear to facilitate the conversion of the acid. If the action of the sun is continued for several months, the Ocas become of the sweetness and consistency of dried figs; they are then called Carri.

The great fleshy root of the *Crambe tatarica*, sometimes called Tartar bread, is eaten in Hungary, peeled and sliced, with oil, vinegar, and salt, or even when boiled. The roots of *Tropæolum tuberosum* are eaten in Peru. Some twenty varieties of the Ti plant (*Dracæna terminalis*) are regularly cultivated at the Samoan Islands. And in other islands of the Pacific the sweet-rooted or the farinaceous-rooted varieties are grown. In some parts of Polynesia a sort of bean (*Pachyrhizus*) is cultivated for the sake of its edible yam-like tubers.

The root of the dahlia contains a bitter principle, of so acrid a nature that its employment as food has always hitherto been despaired of. The *Journal de Chambery* states that this bitter principle is moved by boiling, much in the same manner as the potato is cooked. The dahlia root may therefore, it would appear, in some measure, be substituted for the potato in any time of scarcity of roots.

The Camas is a bulbous root much resembling the onion in outward appearance, but is more like the potato when cooked, and very good eating. The Wappettoo is somewhat similar, but larger, and not so dry or delicate in its flavour. They are found in immense quantities in the plains and the vicinity of Fort Vancouver, on the Columbia, and in the spring

of the year have a most curious and beautiful appearance, the whole surface presenting an uninterrupted sheet of bright ultramarine blue, from the innumerable blossoms of these plants. They are cooked by digging a hole in the ground, then putting down a layer of hot stones, covering them with dry grass, on which the roots are placed; they are then covered with a layer of grass, and on the top of this is placed earth and grass down to the vegetables. Into this the natives pour water, which reaching the hot stones, forms sufficient steam to completely cook the roots in a short time, the hole being immediately stopped up after the introduction of the water. They often adopt the same ingenious process for cooking their fish, meat, and game.

Bryant describes a root, which he met with on the great prairies of California, and which he terms the prairie potato. He considers it in many respects superior to the common potato, and that it might be useful to introduce into cultivation. As no scientific description of the plant is given, it is difficult to determine what it is; for "prairie turnip" and "prairie potato" are terms for a very large number of esculent roots in North America, and include some species of *Psoralea*. A little town called Stowe, in Vermont, uses some 20,000 bushels of a peculiar kind of coarse potato, called the California potato, which yields eight pounds of starch to the bushel. Whether there is any relationship between these potatoes, we cannot state. At least, this subject of new esculent tubers is well worth looking into, and testing practically, systematically, and perseveringly.

In Italy, and other parts of the Continent, baked beetroot is carried about hot from the oven; it is sold in the streets, being purchased by all classes, and affords, with bread, salt, pepper, and butter, a satisfactory meal to thousands. There are few purposes for which beetroot, baked, or even roasted or fried, would not be preferable to boiled.

German tobacco has been bought largely of late by American speculators, and exported to the United States, where it is manufactured into cigars and re-exported to Europe as American tobacco. The American traders found, after a while, that they were not buying even German tobacco, but beet and turnip leaves, with which it is extensively adulterated. German cigars, made partly of beet and turnip leaves, are also exported to the United States, and to other countries. Belgium, Holland, and the Zollverein are the chief consumers of the beet and turnip leaf tobacco; and the article stands in the way of the consumption of the pure American leaf. The quantity of German tobacco in hand at the close of 1861, including the beet and turnip leaf crops, was represented as immense in the American markets. It was held back for higher prices. One single house had 500 quintals of leaves on hand, waiting for a rise in the leaf market.

Under the commercial name of Spanish, or New Orleans moss, the long horse-hair-like fibres obtained about the Mississipi from an epiphyte (*Tillandsia usneoides*), are largely used in America in upholstery purposes, for stuffing cushions, mattresses, &c., possessing considerable elasticity. Naturalists also use it for stuffing birds.

Dr. Terry, of Detroit, in America, has made paper from this so-called moss; and the manufacture has attracted considerable attention in Texas, for there is a region of country there extending one hundred miles from the coast, where an immense quantity can be obtained. The gathering and drying of it requires little or no capital in preparing it for market, and I doubt not, if this business is extensively carried out, that large quantities of the finer quality, instead of being converted into paper, will find their way into the hands of the mattress-makers. In Trinidad, when steamed and dried, it is used as a stuffing material, under the name of vegetable hair. In some places it is also called "Old Man's Beard," and "Barba Hispanica."

The manufacture of bagging for cotton from this so-called moss, was not long since tested in Mississippi, and appeared to be of a useful and durable character. It was obtained in inexhaustible quantities in the woods, at about 1½d. a pound for the collection, and as 2½d. more, amply covers the cost of manufacture, the article could be furnished at about 4d. a yard. The demand for wrapping-cloths for the 3,000,000 or more bales grown in the United States is consequently extensive, and the coarse gunny bags, made of jute and sunn fibre in India, are largely imported. These gunny bags, and old rope or junk, are, after use, ultimately worked up into brown paper.

The twitch or couch grass, the long underground shoots of *Triticum repens*, which is extensively collected after the plough and harrow, and has hitherto been such a troublesome weed to the farmer in clear-

ing his land, is now turned to several useful purposes. In Italy it is employed, under the name of gramigna, as food for horses and cattle. Colonel Maceroni, in his Memoirs, states that upwards of £40,000 sterling worth of this root is annually sold by the peasants to the inhabitants of the city of Naples. In France it has a medicinal repute under the name of dog's tooth. It has been tried as a material for paper, and is collected in large quantities in the fen districts, and sold to the paper-makers at about 12s. a ton, instead of being dried and burnt as heretofore. A spirit has also been made from it.

The waste made by the sawyer or turner, wood dust of various kinds, has several economic uses. Mahogany dust is employed for smoking fish; box dust for cleaning jewellery. The shavings or refuse in making cedar pencils from the wood of the Virginia or American cedar, is used to make the otto of cedar-wood; a hundred-weight of shavings producing about twenty-eight ounces of the otto of cedar.

Besides its employment as a packing material for use in wine-cellars, for sprinkling the floors of tap-rooms, butchers' shops, the arenas of our amphitheatres, riding-schools, &c., there are other applications for sawdust. Mahogany, birch, and rosewood sawdust is used by furriers in cleansing and dressing furs. Sawdust is also used by many manufacturers, as by the needle-makers, and by the nail and screw makers.

It will interest the proprietors of saw-mills and carpenters in general, to learn that the ingenuity of Parisian cabinet-makers, in the Faubourg St. Antoine, has found a use for common sawdust, which raises the

value of that commodity far above the worth of solid timber. By a new process, combining the hydraulic press and the application of intense heat, these wooden particles are made to re-form themselves into a solid mass, capable of being moulded into any shape, and presenting a brilliant surface, a durability and a beauty of appearance not found in ebony, rosewood, or mahogany.

Our forefathers used sawdust for littering their stables, cow-houses, sheep-pens, piggeries, and poultry-houses, the whole being afterwards mixed together and used as farm-yard manure. Sawyers and carpenters, again, who had none of the above provisions, mixed it in their dunghills for growing potatoes; while fishermen used it for smoking fish, and mixing in their ash-pits along with fish refuse, selling the compost to farmers. With these practices many localities are familiar to this day, and have been so from time immemorial. Of these plans, the mixing of sawdust with sheep's dung, urine, slaughterhouse and fish offal, is, perhaps, the most deserving of consideration, because the fermentative qualities of such articles are the best adapted to overcome the comparatively indestructible nature of the dust. Hitherto the great objection to sawings of wood, as manure, has been their slow decomposition. Immediate activity is necessary to give value to manure, and this is what sawdust does not possess. Excrementary and offal matters, on the contrary, are from their nature subject to rapid decomposition, so much so, that half their fertilising value is not unfrequently lost. Indeed, it is impossible to estimate the loss arising from this source.

Now, if the mixing of the two together will effect the decomposition of the former, while it avoids the loss sustained in the latter, the gain must consequently be great. What gives peculiar value to composts of this kind is their disintegrated state: they are fit for drilling in along with the seed by corn and turnip drills at once. Their freeness from sand and other heavy and comparatively useless mineral substances is another merit. The prime cost of the article would be little more than the carriage, while in most localities the supply would obviously be great. We have only to examine our timber-yards for evidence of this. How many ingenious plans have even been contrived for carrying the sawdust down the stream which drives the saw-mill, or into the fire of the steam-engine, where steam power is used. Now that artificial manures have become an agricultural necessity, it is the duty as well as the interest of every one to look first to the resources within his own reach for a supply, and lastly to the market for any balance required. To neglect the former, relying entirely upon the latter, for Peruvian guano, &c., and then complain of high prices, is inconsistency and folly. Were every farmer to procure annually so many tons of sawdust, ground peat, or charred vegetable matter of any kind, which could be had for little money, and to mix them with the excrements of horses, cattle, sheep, pigs, poultry, &c., adding such other articles as peculiar circumstances required, it would exercise a very salutary effect upon the extravagant prices now paid for all kinds of artificial manures. If a farmer can thus manufacture at home as good an article for 20s. as he

can purchase for £5 (and this can be done in many cases), the course which he ought to steer is plain.*

The bye products of the potato-starch manufacture are not without their applications. Thus, the water from which the starch is deposited is well adapted for irrigation. It contains the *débris* of the pulp, and holds in solution six parts in a thousand of azotised matter. It was formerly an inconvenience to the manufacturer, as it contains a poisonous substance, and produces an evolution of sulphuretted hydrogen gas, if kept a short time, from the decomposition of sulphates by the organic matter. The marc of the pulp which remains after the extraction of the starch is made use of in various ways, as food for pigs, horses, cows, and sheep. It must first be deprived of about half its weight of water by expression; for if simply drained it retains too much water to be advantageously eaten by cattle in large quantities. In seasons when fresh alimentary vegetables are abundant, the pulp may be employed as manure; especially as it then contains a small quantity of solanine, and cannot therefore be given to cattle with impunity.

But there are other uses to which potato refuse is turned abroad. After extracting the fecula, the pulp is manufactured into ornamental articles, such as picture-frames, snuff-boxes, and several descriptions of toys of the *papier-mâché* character; and the water that runs from it in the process of manufacture is a most valuable scourer for perfectly cleansing silks and woollens, and such-like articles; it is the housewife's

* Agricultural Gazette.

panaeea ; and if the washerwoman happens to have chilblains she becomes cured by the operation. Potato-leaves have been occasionally fraudulently used to adulterate tobacco.

From a species of *Calathea* (order *Marantaceæ*) the Indians of Trinidad prepare what is termed Tirite straw. It is dyed in various ways,—black, by leaving the straw a few days in the mud ; red, by annotto ; yellow, by turmeric ; blue, by indigo ; violet, by the Mardi gras, or fruit of the *Alpinia racemosa.* The Tirite grass is made into baskets, sieves, and bags.

A new manufacture has recently sprung into existence on the continent of Europe which promises to become one of importance. It consists of the utilization of the acicular leaves or "needles" of coniferous trees, hitherto a waste substance. It was long ago known that pine-leaves consisted of a bundle of tough fibrous material, agglutinated together, and bound into long rigid leaves by means of a resinous integument ; but the practical development of this knowledge is but of recent date. Near Breslau, in Silesia, there are two establishments, both of which are worthy of notice. One of these is a factory where pine-leaves are converted into a kind of wool or wadding ; and the other, an establishment for invalids, in which the waters used in the manufacture of pine-wool are employed as curative agents. These establishments have both been erected by M. Pannewitz, the discoverer of the process employed for obtaining the fibrous material from pine-leaves. This material he calls "woody wool." It can be curled, felted, or woven. We are not acquainted with the

precise method employed by M. Pannewitz, but we have succeeded in obtaining a coarse brownish-yellow fibre by boiling pine-leaves in a solution of caustic alkali for a few hours ; and after rinsing and boiling them again in alkaline liquor, and saturating them in a solution of chloride of lime, a whiter and finer substance, much resembling the pine-wool wadding now being imported from the Thuringer-wald. It is stated that by the mode of preparation employed by M. Pannewitz, the woolly substance acquires a quality more or less fine, or remains in its coarse state. In the former case it is employed as wadding, and in the latter as a stuffing for mattresses. The leaves may be stripped from the trees when quite young without injury, and a man can gather 200 lb. per day.

The first application of this fibrous material consisted in its substitution for cotton with wool in the manufacture of blankets. Five hundred of these were sold to a hospital at Vienna, and, after a trial of several years, they are now exclusively used. Amongst the enumerated advantages, it has been stated that no kind of insect will lodge in the beds, and that the odour has been found agreeable and beneficial. Since this period, the same kind of blankets have been adopted at the Penitentiary and some other institutions in Vienna, as well as in the barracks at Breslau. Its application for stuffing purposes has been no less successful ; the cost being one-third that of horse-hair, and its resemblance so great, that it has been affirmed that when employed in furniture the most experienced upholsterer could not tell the difference. When spun and woven, the thread resembles that of hemp, is very

strong, and may be advantageously employed for many of the purposes for which hemp is used. From this "forest-wool yarn" are now manufactured jackets, spencers, drawers, and stockings of every description; flannel and twill for shirts, coverlets, body and chest warmers, and knitting yarn. These manufactures are recommended for keeping the body warm without heating, and are very durable.

In the preparation of the wool an ethereal oil is produced, which is at first green, but, on exposure to sunlight, becomes of an orange-yellow tint, and when distilled. colourless. It has been successfully employed as a curative agent. It burns in lamps like olive oil, and completely dissolves caoutchouc. The perfumers of Paris are stated to be employing it in considerable quantities. The liquid left by the decoction of pine-leaves is employed in the medicinal bath. The membranous substance and refuse are compressed into blocks and used as fuel: from the resinous matter they contain, they produce sufficient gas for the lighting of the factory in which the production of these useful articles is carried on. The result of one hundred quintals of wool in combustible material is equal in value to six cubic metres of pine-wood.

The forest-wool ware manufactory at Remda, in the Thuringer-wald, advertises forest-wool, oil, spirits, wadding, and the other articles already enumerated. Whether these deserve or not all the high encomiums that have been passed upon them, it is nevertheless an important fact that a material before considered useless is now converted into articles of domestic utility and commercial importance.

## SILK COTTONS.

I HAVE received applications from time to time from brokers, importers, and others, as to the identification and probable uses of various silk cottons; and it may be well to throw together, for convenient reference, the few facts known with regard to them. That some of these may yet be made economically useful on a commercial scale is not at all improbable, seeing that of many of them the material is abundant and to be had cheap. The silky substance found in the capsules of the silk cottons has been tried by European spinners and hatters for their respective purposes, but, from wanting tenacity of fibre, was found generally unfit for the manufacture of any durable material.

At a recent fair held in Liberia, on the West Coast of Africa, a pair of stockings was exhibited, manufactured from the silky floss of the Bombax. These stockings were the result of African skill in spinning and manufacturing. Our mechanism has never yet been capable of utilizing this fibre.

Captain Burton (Lake Region of Central Africa) tells us that in Zanzibar, where the msufi or bombax abounds, its fibrous down is a favourite substitute for cotton, and costs about half the price. In Unyamwezi it fetches fancy prices; it is sold in handfuls for salt, beads, and similar articles. About one maund may be purchased for a shukkah, and from one to two ounces of rough home-spun yarn for a fundo (a knot of ten strings) of beads. At Ujiji the people bring it daily to the bazaar, and spend their waste time in

spinning yarn of it with the rude implements they have at their command.

Mr. Williams, of Jubbulpore, India, has succeeded in spinning and weaving some of the Bombax down so as to form a very good coverlet, and we have specimens of the fabric. The late Dr. Royle suggested that it might easily be made use of for stuffing muffs, for wadding, or for conversion into half-stuff for paper-makers—perhaps for making gun-cotton.

In the "Transactions of the Agri-Horticultural Society of India," vol. iii., p. 274, there is a report upon two pieces of cloth made from it: and it is observed that, from the shortness of the staple of the down and its elasticity, it could not be spun by cotton-spinning machinery.

In the Jury Reports of the Exhibition of 1851 occurs the following:—"Mention may here be made of the very beautiful fibre of the silk-cotton tree (*Bombax heptaphyllum*), which, owing to the shortness and want of strength of the fibre, combined with its peculiar elasticity, is incapable of being spun like ordinary cotton. It is occasionally in India, more especially in Assam, spun into a very loose and large thread, which is then woven into cloth with a warp of some other fibre, and forms a soft, warm, and very light fabric. The silk cotton being a very tender fibre, cannot be used with advantage as a stuffing material alone; but it is highly probable that it might be very advantageously used in combination with other substances, not merely for the purposes of upholstery, but even in the manufacture of mixed fabrics for various other uses in the arts. It was suggested by

Dr. Percival in 1787, and by Buchanan in 1793, that this fibre might be advantageously employed as a substitute for beaver fur in hat-making; and Le Breton states that its importation into some countries was forbidden, for fear that it should be used to adulterate beaver's hair. Practical obstacles were, however, found to interfere with this application, and it appears that they have only recently been overcome."

Silk cotton, from *Bombax Ceiba*, has been sent from British Guiana to the United States for the manufacture of hats.

James Bruce Niel, Esq., in a letter to the Manchester Chamber of Commerce, dated March 10th, 1860, calls attention to the transference of the silk-cotton tree from Persia to the East Indies; but what tree he alludes to is not clear, for the Bombax is a native of both Indies:—

"Now that we have an accredited Minister at the Court of Teheran, in Persia, I would respectfully recommend the Chamber of Commerce to direct his attention to the properties and value of the silk-cotton tree, which is used in the manufacture of clothing in that country. The same would thrive well in India, in the West Indies, or in parallel latitudes. Seeds of the same, ready for planting, might be remitted to those countries by attending to the following instructions.

"Fill an old cask half full of earth, put the seeds as near as possible to the middle of the cask, then fill the latter entirely with moist earth, pressing it down, and finally closing in the cask against air and water. Keep it from contact with sea-water by means of a coating of glue boiled in linseed oil. In this manner,

seeds may be brought from Persia or India in a state of preservation, and fit to vegetate."

The short, brownish, cottony substance, which is found inside the capsules of *Bombax Ceiba* and *B. malabaricum*, under the name of kabu-kabu and mocmain, is used, by the poor inhabitants of the countries where it grows, for making hats and bonnets, and stuffing chairs and pillows. It is not made into beds, being too warm for those climates. Next to eider down, it is the softest material for stuffing. The beautiful purple down of *B. villosum* is spun and woven into a cloth of which garments are made and worn by the inhabitants of Mexico, and it retains its purple colour without being dyed. *B. septenatum* or *heptaphyllum* is said to furnish the same kind of material.

The *Ochroma Lagopus* of Jamaica contains in its capsules a fine, soft, mucous down, which enwraps the seeds, and which is said to be employed in the manufacture of English beaver hats.

Other silk cottons, the *Eriodendron Caribæum*, or *Bombax pentandrum*, Lin., of the West Indies, and the *E. anfractuosum*, Dec., furnish the silky down known in the East under the name of capock. The woolly coat of the seeds of most of the species is gathered in different countries for stuffing cushions and similar purposes.

The cottony seeds are used in India as soporific pillows, like those famous poppy ones of Somnus, or as the hop is often prescribed here. The silk down, moreover, forms an excellent moxa.

Edwards ("Voyage up the River Amazon") makes mention of "the samauneira tree, which yields a long-stapled silky white cotton; it grows upon the banks of

the Rio Negro in great abundance, and could probably be made of service, were it once known to the cotton-weaving communities. It is excessively light, flying like down ; but the Indians make beautiful fabrics of it." This is, no doubt, the *Eirodendron Samauna.*

The wool of various Sterculiaceæ—as of the balsa (*Ochroma Lagopus,* Swartz), ceiba (*Eirodendron Caribæum,* Don), and barrigon (*Pachira Barrigon,* Seeman) —is employed in Central America for stuffing pillows, cushions, &c.

The seeds of the Syrian swallow-wort (*Asclepias Syriaca*) are covered with a thistle-like down an inch or two in length, which it was at one time proposed to spin into textures for wearing-apparel. Articles of dress have, we learn, been manufactured with it both in France and Russia. It is well adapted for stuffing mattresses and pillows. An allied species is very common in the United States, where it is called silk-weed, and there used for stuffing bedding. Specimens of it from Canada were shown at the Exhibition of London in 1851, and at Paris in 1855. The down of the Asclepiads, Dr. Royle observes, may no doubt be turned to some useful purposes, and therefore makes the plants abounding in fibre more valuable, as yielding a double product.

Dr. A. Hunter, of Madras, has drawn attention to the value of the fibre of one of the Ascle kinds, the yercum silk cotton (*Calotropis gigantea*). The plant thrives best in the neighbourhood of neglected rubbish-heaps, whence it derives an abundant supply of nitrogen, which seems essential to its perfection. The difficulty of spinning its hairs, which do not contract in the same way as

cotton, has been overcome by new machinery. A variety of fabrics of a light, soft texture, were lately exhibited in Madras by Messrs. Thresher & Glenny, made from the yercum silk cotton mixed with other fibres. The cloth is well suited as a substitute for flannel. Several large bales of the fibres have been sent to London. It is expected that, with aloe and plantain fibre, they will be fit for the finest descriptions of note-paper. The whole plant is of commercial value. In Madras the silk cotton of the pod is collected, in Bombay the fibre of the bark is used instead of flax, and in Bengal the natives collect the milky juice as a substitute for shellac and gutta-percha.

"Mr. Moncton, C. S., has proposed making use of the downy substance contained in the follicles of the mudar or yercum, and, indeed, has had paper made of it, as well pure as when mixed with two-fifths of the pulp of the sunne hemp, such as the natives use for making paper. As the glossy and silky, but comparatively short, fibre is difficult to spin, a mixture of one-fifth of cotton was made in order to enable it to be worked. A good wearing cloth, which stands washing and takes a dye, was produced. It is, however, well suited for stuffing pillows or coverlets. Mr. Moncton calculated that its cost would be one rupee a maund. The silky down of the pods is used by the natives on the Madras side in making a soft, cotton-like thread." (Dr. Royle, on "Fibrous Plants of India.")

Wild cottony down, with a fine glossy fibre like silk, grows abundantly in the valley of the Amazon, and is used at Guayaquil to stuff cushions and mattresses. Some silk manufacturers in France, to whom specimens

of this cotton were sent by Mr. Clay, the United States *chargé d'affaires* at Lima, thought that, mixed with silk, a cheap and pretty fabric might be wove from it.

The cotton which is found on the seeds of *Chorisia speciosa* is used to stuff bolsters and pillows in Brazil, where it is called by the inhabitants, "Arvore de Paina." It has been imported into Liverpool under the name of vegetable silk.

In the Prussian department of the London Exhibition of 1851, a fibrous silky substance was shown, obtained from plants growing in Prussia and several other countries. It is applied to silk buttons and fringes, and available also for spinning and weaving.

The cotton of some species of the Eriocephalus of Africa appears to have much tenacity, though probably open to the objection of being too short in the staple, and of growing in too minute quantities. The cotton does not grow in the capsule, but between the corolla and calyx of the flower. Each plant bears freely, and plants may be raised from seeds or cuttings.

A species of Asclepiad resembling a wild asparagus, which grows in the greatest abundance over almost the entire country in Canada, furnishes a fine silky down in its pods, which has been applied with success to the manufacture of hats in the province, being substituted for felt, and worked similar to hare and rabbit down. It is sometimes mixed with a fourth part of wool. Were it to engage the attention of the manufacturers of textile fabrics, it might be employed for a profitable purpose.

Among the small number of useful products (observes Mr. M. C. Cooke) derived from ferns, there are four,

of closely analogous character, which have been more or less confounded, but which, from recent information, we are able to distinguish with precision, as well as to add some particulars which we think will be of interest.

All the four products consist of the silky hairs found clothing the rhizome and lower portion of the stalk or *stipes*. Two of them are of interest for their economic applications, and two for their medicinal properties (real or imaginary). The first is produced in the Sandwich Islands, the second in Madeira, and the others in islands of the Indian Archipelago.

I. *Pulu* is, as far as at present known, solely the produce of the Sandwich Islands, from whence the first importation, of which we have any record, reached Liverpool about fifteen years ago, and to which, with subsequent importations, Mr. T. C. Archer called attention in the *Pharmaceutical Journal*, vol. xvi., p. 322.

Three species of Cibotium, viz., *C. glaucum*, Hook. et Arnott, *C. Chamissoi*, Kaulf., and *C. Menziesii*, Hooker, are described as natives of the Sandwich Islands. All these were originally described at different times, each by a different author; and Mr. J. Smith is inclined to believe that if a good observer were resident on the spot, and had time and facilities for examining the various phases exhibited by them in the different places of their growth, age, &c., that the whole would resolve into one species. Be that as it may, all produce Pulu in more or less quantity, according to place and other circumstances.

From a recent Sandwich Islands newspaper, and other sources, I am enabled to add something to the

history of this commercial product. It appears that Pulu has now become an established article of export from that locality. Although its use for pillows, &c., has been known amongst the natives from time immemorial, and a little may have been exported prior to 1851, yet, as an article of trade, it only dates back to that year.

The Custom-House returns of the Hawaiian Islands give the following amount of export in each year :—

| | |
|---|---|
| 1851 .. .. .. .. .. | 2,479 lb. |
| 1852 .. .. .. .. .. | 27,088 ,, |
| 1853 .. .. .. .. .. | 12,739 ,, |
| 1854 .. .. .. .. .. | 34,031 ,, |
| 1855 .. .. .. .. .. | 82,558 ,, |
| 1856 .. .. .. .. .. | 247,740 ,, |
| 1857 .. .. .. .. .. | 260,560 ,, |
| 1858 .. .. .. .. .. | 313,220 ,, |

It is exported principally to San Francisco, though not confined wholly to that port, some being sent to Australia, Vancouver's Island, and other places. Messrs. Harris, the principal dealers in Pulu, became by accident engaged in the trade. In 1854 they had a suit with a storekeeper in Honolulu, and judgment being rendered in their favour, about 800lb. of Pulu was all they could obtain in satisfaction. This material was then worth little or nothing in the market ; they, however, took it, and shipped it to San Francisco, where, after some delay, it realized twenty-eight cents. (14*d.*) per lb. This circumstance decided them in commencing the trade, and now two-thirds of the exports are supplied by them.

The fern which produces the Pulu grows on all the

high lands, commencing at an elevation of about 1,000 feet, and extending upwards to 4,000 feet. In size it frequently attains to fifteen feet in height. Though found more or less on the five principal islands, the trade in it is chiefly confined to the districts of Hilo, Hamakua, and Puna, in Hawaii. The Pulu is produced around the stalk where the leaf or stem shoots out from the stock of the fern, and only a small quantity is found on each plant, amounting in weight to about two or three ounces. It takes about four years for a plant to produce this amount.

Owing to the large quantities collected of late years, the article is becoming scarce in the Hilo district, though in the Hamakua and Puna districts large quantities still remain. But as it is farther for the natives to go to obtain it, and as more expense and fatigue are encountered, the cost is gradually advancing, and the probability is that it will continue to advance each year to the extent of a cent per lb. The number of persons engaged in gathering Pulu varies: including men, women, and children, probably from two to three thousand are now dependent on it for a livelihood, receiving generally from five to six cents per lb. on delivery. The labour of gathering Pulu is very tedious and slow. When picked, it is wet, and has to be laid out to dry on the rocks or on mats. In favourable weather it will dry in a day or two, but generally in the Pulu region wet and rainy days prevail, so that frequently the natives do not get their Pulu dry after several weeks, often taking it to market in too wet a state. The dealers have constantly to contend with this inclination of the natives to sell wet Pulu, as it

makes considerable difference in the weight when dry. The facilities for drying, packing, and shipping, are improving every year, and the article now shipped is generally dry and in good order, closely packed in wool bales. The trade is reduced to a system, and though there is no probability of any great increase, it will doubtless continue a staple export.

II. This product, of which no local name has come to our knowledge, has long been known and used in Madeira for stuffing cushions, &c. It is the product of *Balantium culcita*, Kaulf., a fern found in Madeira, Teneriffe, and the Azores, and also in Jamaica and New Granada. The silky hairs of this species bear a great resemblance to those of the various species of Cibotium. We are not aware of any exportation of this substance, nor the extent to which it is collected. In the island of Fayal, one of the Azores, *Dicksonia arborescens*, L'Herit., grows round the margin of a lake in such profusion, that the silky down of its stems is used by the principal inhabitants as stuffing for their mattresses.* Trunks of the *Dicksonia* and other tree ferns from Tasmania were shown at the Exhibition of 1862.

---

## FIBROUS SUBSTANCES.

TECUM, or Tucum fibre, ist he native Indian name for the produce of a palm-leaf resembling green wool, imported into Liverpool from Brazil. This fibre is

* The *Cibotium Schiedei*, Schlecht. et Cham., of Mexico, and *Thyrsopteris elegans*, a native of Juan Fernandez, also produce similar silky hairs.

obtained from the *Astrocaryum vulgare* of Martius. From its unexpanded leaves the natives manufacture cordage, bow-strings, fishing-nets, hats, fans, beautifully fine hammocks, and other articles where fineness combined with strength is required.

The fibrous outer covering, or husk, of the cocoa-nut, when macerated or prepared, is termed "coir," and is twisted into yarn and spun into rope. This product is extensively shipped from Ceylon, in the various forms of coils of rope and hawsers, bundles of yarn, and pieces of junk and loose fibre. The value of this export averages about £30,000 from Ceylon. Twenty years ago it was not a fourth of this amount. Large quantities are imported into this country as "dunnage" in ships; and the husk is collected from the fruiterers and itinerant vendors and sold for spinning.

Coir is the fibrous rind of the nuts, with which the latter are thickly covered. There are several ways of stripping the fibres from the husk. One is, by placing a stake or iron spike in the ground, and by striking the nut on the point, the rind is easily separated from the shell. The husks are first separated from the nuts, and then placed in salt or brackish water for about twelve or eighteen months; they are then scraped and cleaned for use. There exists, however, no necessity for steeping the husks so long in water, it having been found that a shorter time is sufficient for the purpose. On the coast of America, when a running stream of water is not near at hand, the coir manufacturers dig holes in the sand below high-water mark, and bury the rind of the cocoa-nut before beating it. Subse-

quently it is rubbed with the hand until the interstitial substance be completely separated from the fibrous portion of the husk. The rind of forty nuts will yield about 6 lb. of coir. The next operation is to twist the fibres into yarn, which is manufactured into cordage of all sizes. The export of this substance is somewhat checked by the rudeness of the process of manufacture, and the want of proper machinery. Women are seen up to their knees in water beating out the coir from the husk of the cocoa-nut, which has been previously well soaked. It is then cleaned and laid out to dry, after which it is disposed in layers, on which stones are placed, from whence it is drawn out by the hand and twisted into the yarn from which the rope is made. It is rather difficult to twist. It has lately been proved that the fibre from the husk of the ripe fruit is greatly improved in quality and appearance by this beating, soaking, and washing, and that the old method of steeping in salt water for one or two years is quite unnecessary, and that it produces a harsher and dirtier coir. The tannin which this substance contains prevents the fibre from rotting; but most of the coir of commerce is of a dirty, harsh produce, very different from many of the clean and dyed samples produced, which are suited to a superior class of manufactures, as fine mats and furniture brushes. Coir is much used in India, in place of hair, to stuff mattresses, cushions for couches, saddles, &c., and for making brooms and brushes to whitewash houses. In Europe it is chiefly used for cocoa-nut matting; but fancy articles, such as hats, bonnets, &c., have been made of it. In the West Indies the husk, or fibrous

pericarp, is employed as a rubber to polish furniture and the wooden floors of rooms, &c.

In South America the separation of the husk is commonly obtained by tearing it off by the hands, aided by the axe. A simple application of the foot-power, used in the common turning-lathe or knife-grinding wheel, would enable one man to do the work, at present the task of several. A double-knife, acting crosswise, could be made to cut the nut and husk in two, and so prepare it for the extraction of the substance.

About four days' maceration in fresh water is requisite. After this, the husk must be beaten till the fibres separate, when it should be well washed, dried, and packed in pressed bales.

For the purpose of beating it out, an instrument in the form of bars, somewhat in the shape of a gridiron, should be used. It is obvious that this process might also be advantageously performed by machinery. One person can beat out with the hand, according to the age of the nut furnishing the husk, from 7 lb. to 14 lb. per day,—say, for an average, 10 lb.; but by the use of proper instruments his work might be increased fourfold.

The character of coir has long been established in the East, and is now well known in Europe, as one of the best materials for cables, on account of its strength, lightness, and elasticity. These cables are further valuable, from being durable, particularly when wetted with salt water.

Numerous instances have been related of ships furnished with cables of this light, strong, and

buoyant material riding out a storm in security, while stronger made, though less elastic, ropes of other vessels have snapped in two, and even when chain-cables have given way. Indeed, until chain-cables were so largely introduced, all the ships navigating the Indian seas were furnished with coir cables. When prepared in the following manner, they are said to be indestructible either by fresh or salt water :—The strands are dipped in a composition of tar and fish-oil, and deprived of all the superfluous stuff by means of a machine, before they are twisted together.

The shells of the cocoa-nut are also utilized. The value of those exported from Ceylon averages several hundred pounds a year. They are largely used for hookahs or pipe-bowls; they are also mounted for drinking-cups, made into ladles and spoons, turned into beads for rosaries, and make excellent charcoal for dentifrice.

The average produce of cocoa-nuts in the whole of Malabar was estimated by Royle at from 300 to 400 millions annually. So far back as 1837 there were more than 5½ million cocoa-nut-trees in Travancore; and 60,000,000 nuts are annually consumed in the country.

Poonac is the refuse of the copperat or kernel after the oil has been expressed; it is very fattening to fowls and cattle, and forms the best manure for young cocoa-nut-trees, as it returns to the soil many of the component parts which the tree has previously extracted for the formation of the fruit. For this reason it has been found worth while to transmit the poonac to

those localities where the cocoa-nut-tree grows far inland away from the saline soil of the coast. The cocoa-nut-palm abstracts from the soil chiefly silex and soda; and when these two salts are not in abundance the trees do not thrive.

The Victorian and South Australian stringy-bark-tree claims particularly our attention amongst those indigenous plants yielding fibres. The thick fibrous bark, employed by settlers, whenever obtainable, as their first roof, is devoid of tenacity, but may, as experiments have shown, be employed for the manufacture of a rough kind of paper, although of brittle texture. The bark of *Sida pulchella*, and of various *Pimeleas*, and of *Brachychiton*, affords to the natives the means of making cordage; but none of these fibres can be compared in yield to those which European culture has now made universally available.

---

## MATS AND MATTING.

Mats and matting are composed of a variety of textures: hemp, coir, rope, rushes, reeds, bark, grass, &c., but of the specific material of many of the imports we have no very definite information. A few words on the statistics of the trade, which is rather important, may not, however, be out of place. We receive imports, in bales and bundles, to some extent from many foreign quarters, and the prices vary with the quality and description.

The declared value of the imports have been as follows :—

| | | | | | |
|---|---|---|---|---|---|
| 1846 | .... | £46,954 | 1855 | .... | £11,222 |
| 1847 | .... | 39,168 | 1856 | .... | 21,664 |
| 1848 | .... | 29,012 | 1857 | .... | 19,284 |
| 1849 | .... | 30,851 | 1858 | .... | 22,548 |
| 1853 | .... | 40,115 | 1859 | .... | 22,020 |
| 1854 | .... | 36,551 | 1860 | .... | 25,054 |

Mats are largely used for sleeping on in most tropical countries, as in Africa, the Mediterranean, India, and Central America. Even in China there is an extensive demand for this purpose. Thus, in the half-year ending December, 1860, the import of 32,431 sleeping-mats are recorded at the port of Shanghai, valued at 1,621 dollars, or less than 3*d.* each. Mats are exported from China to all parts of the world, but principally to India, America, and Australia. The Chinese table-mats are very beautiful ; the demand has increased for them, and consequently augmented the importation of rattans. Thousands of people are employed in the manufacture of mats for boat sails. Fifty mats, of 6 feet by 4, go to a bundle (or 100 catties), price about 15 dollars per bundle. There is a large exportation from Chusan. The annual exportation of mats to the United States is upwards of 10,000 rolls, of 40 yards each, at 4 dollars a roll.

From Canton the exports of matting are considerable. In 1850 there were but 6,399 piculs (of $133\frac{1}{3}$ lb.) shipped, valued at 52,500 dollars ; in the half-year ending December, 1860, 17,282 piculs, valued at 138,262 dollars, were exported. From Penang about 4,000 piculs of matting are annually shipped.

From Alexandria large quantities of matting are exported, sometimes to the value of £22,500 a year.

The West African mats are very neatly made; they are chiefly formed of the stalk of the plantain, and some kinds of grasses, dyed, to form the border patterns, &c.

In Central Africa cloths are made of the fibres of the wine-palm (*Raphia vinifera*), mixed with cotton, by the tribes tributary to Benin, on the right bank of the Kworra, below the confluence called by Hausa and Nupe "Gura sakim." Among the collection of articles sent home to the International Exhibition of 1862, by Dr. Baikie, R.N., from the tributaries of the Niger, were Pinnæ of leaves of wine-palm, dried as offered for sale; also prepared for tying grass for thatching, for twisting into small rope, &c., by the midrib and the spiny edges being taken away.

A white mat of leaves of fan-palm (*Borassus*), made in Bornu. One with black, one with white compartment in centre, which is dyed by means of the stalk of a species of sorghum, made in Bornu.

Fine mats of leaves of *Phœnix spinosa*, dyed, made in Nupe. Hats are made of the same material and of the leaves of the doom-palm.

Round and oval mats of the same material, made in Nupe. The round form is only used by chiefs and great men. Mats, yellow, black, and red, of leaves of Borassus: dyed yellow by a root, of which specimens have been sent to Kew; red, by the sorghum; and black, by the same, differently prepared. This is made in Ase or Kakanda, along the Kworra, on both sides, between Nupe and the Confluence. It is called by the Hausa

"giwa," or elephant mat, which name is adopted by Nupe.

The coarse kinds of matting used in England are employed for covering the floors of churches, and public and private buildings. Specimens of door-mats and baskets, made of deal-shavings, in Sweden, may be seen in the Museum at Kew.

Mats and baskets are essentially necessary in all wine-making countries, and must in time prove a profitable trade in many of our colonies; and, therefore, the discovery of suitable materials should occupy the attention of agriculturists and planters. The capaches, in which grapes and olives are placed one over another under the mill or press,—the mats, in which raisins and figs are packed for exportation,—form a distinct branch of economy in the husbandry, and the materials are cultivated on the estates as well as the wine and the olive.

The leaf of the cabbage-palm of Australia would be available there for the purpose; but it is likely to be evanescent, like the cedar of the country, and timely measures should be taken for its extended cultivation. The young tree is still to be found in many of the gullies to the southward of Sydney.

The chief imports of mats, in 1860, were £18,227 in value, from China; £6,605, from Russia; £1,736, from the United States; and smaller proportions from Holland, and other parts, bringing up the total to £28,084.

The long, slender branches of the shining or red willow (*Salix lucida*) are sometimes used for baskets in New Brunswick; but they are rather brittle. The

Milicete Indians scrape the bark from the young twigs, and when dry mix it with their tobacco for smoking. They are very partial to this admixture, the odour of which is much more agreeable than that of pure tobacco.

A variety of materials from the vegetable kingdom, chiefly waste, have been used, or may be used in the manufacture of bonnets and summer hats, matting, &c. Among those employed for bonnets and hats are wheat and rye straw, palm-leaf, splints from the willow-tree, &c. From the leaves of the cocoa-nut-tree of the Seychelles, hats are manufactured of a superior quality, which are worn by all classes of inhabitants.

Many of the grasses are available for the purpose; one called the June grass is employed in Massachusetts. There are also in the West Indies the cane-arrow, and a variety of excellent grasses, fit for making hats and bonnets, baskets, mats, &c., which at present run to waste.

In New Brunswick, brooms are made of the twigs of the yellow birch (*Betula lutea*) and the Indian women make brooms of the wood by splitting it up. Near New York, brooms and scrubbing-brushes are made of iron-wood (*Carpinus ostrya*), by shredding the end of a stick of suitable dimensions.

Brushes are made in Sardinia from the Trilobo, or Piedmontese heath sprigs. Common brooms, or besoms, with us are chiefly made of heath and birch. Immense quantities are made in Southwark, in the neighbourhood of Ulverstone, and in North Wales. The value of those manufactured in this country has been estimated at £500,000. At the city of Adrianople, there is a large trade in brooms—400,000 to 500,000

dozen being sold annually at about 3s. a dozen, or more than double the price of those sold in England.

During the deficiency of bristles resulting from the Russian war, various new substances were introduced, among others a stout and durable material, termed Mexican grass—the native name of which is Itsle. After being submitted to various tests, the results proved it to be in every respect an excellent substitute for bristles in the manufacture of brushes. It is now in general use for eighteen or twenty different kinds of brushes; indeed, with the exception of hair brushes, brooms, and paint-brushes, it answers for almost every kind of brush made. The principal advantage of this material is, that while it is equally as strong and flexible as bristles, it is much cheaper. A scrubbing-brush which formerly cost 1s. 2d. may now be had for 7½d. Even the refuse of the grass is an excellent substitute for curled hair. One article of manufacture to which this material is peculiarly adapted is ladies' crinolines. This grass is fast superseding the use of bristles for those kind of brushes for which it answers. It has been patented as a substitute for hair in mattresses. The outer cuticle is first removed by passing it between rollers and stretching it, and it then forms a good stuffing material.

It is chiefly shipped from Tampico, and the exports thence, principally to Great Britain, were in—

| | | lb. | | Value. |
|---|---|---|---|---|
| 1857 | .... | 2,978,350 | .... | £134,025 |
| 1858 | .... | 2,819,271 | .... | 126,161 |

When gathered in autumn, before they are injured

by the frost, the leaves of the beech, on account of their elastic quality, make better palliases than either straw or chaff, and they last seven or eight years.

The leaves of *Vitex trifolia* are used in India to stuff pillows, and to cure catarrh and headache.

Other useful products than the grain and its leafy covering have been obtained from the maize. Sugar and molasses have been procured from the stalk. The grain is largely used for distillation. A bushel of corn gives over a pint of oil, which is easily purified, and burns with a clear bright flame. A distillery has been established in the vicinity of Lake Ontario, where oil is extracted at the rate of sixteen gallons from 100 bushels of Indian corn, leaving the remaining portion of the corn more valuable, and in better condition for distillation, than before the oil was extracted. The cob is given as food to live stock, and has also been ground to make a kind of bread.

The husk, or leafy covering is used for packing oranges and cigars, and for stuffing mattresses in America. Paper is also made there from it. As the annual crop harvested exceeds 600,000,000 bushels, there ought to be plenty of raw material from this substance. Most of the American printing paper is made of cotton, on account of the extensive use of that article, and hence it is soft, easily torn, and perishable. The husk of the maize is a very fair substitute for horse-hair, possessing considerable elasticity, and may be had in any quantity, and at a comparatively small price.

It forms a good stuffing material for palliases or beds. They should be the inner husks, clean and

whole, and spread on some airy floor for a few days in order that they may become perfectly dry. Then they may be put into the ticks, and they will last for a long period. Some of these under-beds have been in use more than twenty years; and with an annual ventilation and beating, by being emptied on a chamber floor, and with a little replenishing with new husks, they are as good and lively as when new. The husks had better not be stripped up, as some have done. This makes the substance finer and more liable to mat up. The husks should be whole, and, drying in irregular shapes, they will retain those shapes and lie lively in the bed for a long time. There is a beard, or fuzziness, on each husk, that prevents any insects crawling through the beds; consequently they are entirely free from vermin, of which straw is apt to be full. They are, therefore, clean, sweet, and healthy. A good husk bed is equal to the best mattress for summer use, and we have slept on feather beds in winter not half so soft as these.

The best time to save the husks is when in the act of husking the corn. By a little practice, the husker will soon learn how to strip off first the outside coarse husks, and by another motion, seize the inner ones (removing the silks at the same time), and dropping them into a basket at his side. It will take a little longer to husk out a bushel of corn thus, but the husks will most richly repay for the extra time. When this process has been omitted, it will not be a great job to visit the husk-pile after the corn is removed, and by hand pick out enough of the clean inside husks to make a bed. After being made, there

is no need of ever going after straw with which to fill the under-beds. The job once done, is done for life.

The cob, on which the ears of maize are ranged, is used for various purposes in North America. It forms a ready stopper for bottles. Ground into meal, it is an excellent food for dairy cows. In the winter, Mr. R. F. Bingham, of Ellsworth, Ohio, found by comparative trials that it was cheaper and more efficacious than other food. He tried corn, oats, and rye, and gave six cents' worth per day to a cow for a week—she yielded 138 lb. of milk, making $6\frac{3}{4}$ lb. of butter. He then fed her with six cents' worth of cob meal per day, for a week—she gave $157\frac{1}{2}$ lb. of milk, making 7 lb. 7 oz. of butter. He then tried the cob meal *scalded*, for a week—the cow gave $156\frac{3}{4}$ lb. of milk, yielding 6 lbs. 6 oz. of butter.

Indian corn itself is, however, frequently a complete drug in many of the States, when the crop is abundant, the price low, and there is a want of convenient transit to market. Sometimes it is converted into whisky, else it is fed off to hogs, and latterly, on the Illinois prairies, it has been used as fuel instead of coal, and is found an excellent substitute. In the district referred to, corn is $13\frac{1}{2}$ cents per bushel, and coal 12 to 17 cents. Not only is the difference in price in favour of corn, but a bushel of it gives more heat than a bushel of coal.

The molasses drained from the sugar hogsheads, in sugar-laden vessels, although mixed with the bilge-water, is useful for distilling purposes. In all sugar colonies, the sweet washings from the sugar-boilers, and

fermenting juices from the cane-juice receivers, known under the name of "dunder" in the West Indies, is used in the distillation of rum.

An English inventor, named Stammers, has discovered that very good gas for illuminating purposes may be obtained from molasses, in the proportion of a cubic yard of gas from about two pounds and a half of the latter. The refuse of the beet-root employed in the manufacture of sugar also yields a good lighting gas, and, on account of its inferior price, is better adapted to that end than molasses; 225 lb. of the beet-root refuse yield forty cubic yards of gas and 8 lb. of ammoniacal solution.

Spent bark from the tanneries, pressed and dried by the hydraulic press, has been used as fuel for the boilers of some steam-engines, and has also been employed to supersede gunpowder for blasting. The *Mining Journal* says:—"Our various correspondents on the loss of life occasioned by the careless use of naked gunpowder in mining operations, as well as the mining interest generally, will be glad to learn of a new product less liable to explosion from careless treatment, and very much cheaper than gunpowder for blasting rocks, &c., and which, after having been exposed to damp or wet, does not lose its explosive power, but becomes serviceable again on being dried. This substance has been invented by a Mr. Reynaud, who has named it 'pyronome.' As compared with gunpowder, its specific gravity is much lighter, and it produces the same effect. Its cost price is considerably less than gunpowder, but it cannot be advantageously used for fire-arms. It is composed

of nitrate of soda 52·5 parts, residue of tan (after it has been used for tanning) 27·5, powdered sulphur 20·0 = 100·0 parts. The operations for its preparation are as follows:—1. Dissolve the nitrate of soda in a sufficient quantity of hot water. 2. Mix the tan in this solution in such a manner that all parts may become perfectly impregnated. 3. Mix the powdered sulphur in the same manner. 4. Take the product from the fire and dry it. When thoroughly desiccated it may be placed in sacks or barrels for use. This product, for the purposes named, will be found far superior to gunpowder, and we doubt not will be received as a boon both by miner and mine-owner, and ought to come into general use. Arranged in cartridges, no possible accident could happen; and, besides being about 15 per cent. cheaper than gunpowder, it possesses the rare quality of retaining its explosive powers after being subjected to damp or wet, simply requiring drying; and its preparation is so exceedingly easy as to be within the power of every one to manufacture for himself."

The principal tree and shrub vegetation of Australia being myrtaceous, it may be anticipated to what an unlimited extent the volatile oil of these plants could be obtained for technological purposes. Eucalypti leaves were, for several years, employed for making gas to light one of the country towns of Victoria. The Eucalyptus furnishes also the Australian kino resin in unbounded quantity. The leaves of a stately fan-palm (*Livistonia Australis*) are much sought in Australia as the material for the manufacture of what are known as cabbage-tree hats.

There are few plants indigenous to Victoria, as far as known, which may be regarded practically valuable for their perfume; none of them would supersede in odour or in yield of essential oil any of those already elsewhere in use; but it should be remembered that many of these native plants are as yet imperfectly examined in this respect, and it is, therefore, possible that future experiments may prove the existenee of plants possessing a sufficiently copious supply of scented oil to render them available for distillation.

The great prevalence of myrtaceous trees and shrubs throughout Australia is a well-established fact. All, without exception, are eharaeterized by the presenee of a greater or lesser quantity of essential oil pervading leaves and flowers. This applies not only to the huge masses of Eucalypti which mainly constitute the Australian forests, and all yield, as stated before, an aromatie volatile, often however somewhat camphoric, oil, but also to the "tea-trees," speeies of Melaleuca and Leptospermum, so eallcd beeause their oil, which gives to an infusion of their leaves an aromatic taste either strong or pleasant, was used by Cook and other early Australian navigators as an anti-seorbutic tea.

More important as perfume plants are some of the species of Bæckia and Chamælaueieæ, embraeing numerous handsome and common shrubs of the Myrtle family, of which some are impregnated with large quantities of truly well-sccnted oil. But of their aetual yield we have no exaet reeord.

How far the plants of the Rue tribe, which are all strongly odorous from essential oil, arc of value for perfume distillation, future expcriments must prove.

The impression, however, will probably be correct, that they furnish an oil useful for medicine rather than for the toilet.

The plants of the Mint tribe deserve here particular notice ; three kinds of native mint in Victoria possess an exceedingly pleasant odour, very different from that of the crisp or the peppermint. The species of Prostanthera are nearly all strongly and agreeably scented. Their oil could be cheaply enough obtained, but would be only useful for admixture with other scents. The *Humera elegans* has been recommended as a plant worthy of distillation on account of its balsamic fragrance. Very many of the Acaciæ, indigenous to Australia, produce flowers of a most agreeable odour, and a useful distillation may possibly be obtained from them. If so, this point will require more attention, as these trees and shrubs are very gregarious, and produce flowers in the utmost profusion.

Many nettles are eaten raw and in soups in Sikkim, especially the numerous little juicy succulent species. The husks of the great yellow-flowered *Begonia* are cut up to make sauce (as we do apple-sauce), for pork ; the taste is acid and very pleasant.

The Plantain is sometimes so abundant and cheap in many of our colonies, that it might, if cut and dried in its green state, be exported with advantage. It is in this unripe state that it is so largely used by the peasantry of this colony as an article of food. When dried and reduced to the state of meal, it cannot, like wheat-flour, be manufactured into maccaroni or vermicelli,—at least, the maccaroni made from it falls to

powder when put into hot water. The fresh plantain, however, when boiled whole, forms a pretty dense, firm mass of greater consistency and toughness than the potato. This mass, beaten in a mortar, forms the "foo-foo" of the negroes. The plantain meal cannot be got into this state unless by mixing it up with water to form a stiff dough, and then boiling it in shapes or bound in cloths. Plantain meal is prepared by stripping off the husk of the plantain, slicing the core, and drying it in the sun; when thoroughly dry, it is powdered and sifted. It is known among the creoles of the colony under the name of "Conquintay." It has a fragrant odour, acquired in drying, somewhat resembling fresh hay or tea. It is largely employed as the food of infants and invalids. As food for children and convalescents, it would probably be much esteemed in Europe, and it deserves a trial on account of its fragrance, and its being exceedingly easy of digestion. In respect of nutritiveness, it deserves a preference over all the pure starches, on account of the proteine compounds it contains. The plantain meal would probably be best and freshest were the sliced and dried plantain-cores exported, leaving the grinding and sifting to be done in Europe.

The flavour of the meal depends a great deal on the rapidity with which the slices are dried; hence the operation is only fitted for dry weather,—unless, indeed, when there was occasion for it, recourse were had to a kiln or stove. Above all, the plantain must not be allowed to approach too closely to yellowness or ripeness, otherwise it becomes impossible to dry it. The colour of the meal is injured when steel knives are

used in husking or slicing, but silver or nickel blades do not injure the colour. On the large scale, a machine on the principle of the turnip-slicing machine would be employed. The husking could also be greatly facilitated by a very simple machine. Were the plantain meal to come into use in England, and bear a price in any way approaching to that of Bermuda arrowroot, it would become an extensive and very profitable export. Full-sized and well-filled bunches give 60 per cent. of core to 40 per cent. of husk and top stems; but in general it would be found that the core did not much exceed 50 per cent., and the fresh core will yield 40 per cent. of dry meal; so that from 20 to 25 per cent. of meal is obtained from the plantain, or 5 lb. from an average bunch of 25 lb.; and an acre of plantain-walk of average quality, producing during the year 450 such bunches, would yield a ton and 10 lb. of meal, which, at the price of arrowroot, namely, 1*s.* per lb., would give a gross return of £112 10*s.* per acre. A new plantain-walk would give twice as much. Even supposing the meal not to command over half the price of arrowroot, it would still be an excellent outlet for plantains whenever, from any cause, the price in the colony sank unusually low.

The plantain has frequently been suggested as an article of export from tropical countries, where it is grown. In its ripe state, no unobjectionable and sufficiently cheap method of preserving it has yet been adopted. And yet, when fully ripe and dried in the sun, it is in that state analogous to the dried fig, raisin, date, &c.

In Mexico it is called "plantano passado." It is prepared in considerable quantities in the hot region of the Western Coast of Mexico, for consumption in the elevated districts of the interior. It is made up into packages of 75 lb. weight, in the leaves and fibre of the plant, and subjected to considerable pressure. The cost of production is very moderate. For a further account of this product, and of the method of preparing it, see Transactions of the Society of Arts, vol. 50, p. 43, that society having awarded their silver medal for the first sample brought in 1834.

Colonel Colquhoun exhibited some in 1851, which had lain in the stores of Woolwich since 1835. A quantity of granular or efflorescent sugar had formed in the cavities.

Vinegar from the plantain is obtained by a very simple process. When there is a temporary glut in the market, the surplus, when yellow, is thrown into baskets supported on open barrels. The fruit liquefies and drops into the reservoir, where the juice ferments, and speedily becomes vinegar. No water is used in the process.

Cassareep is the concentrated juice of the roots of bitter cassava (*Janipha manihot*), and the basis of the West India dish, "pepper pot." One of its most remarkable properties is its high antiseptic power, preserving any meat that may be boiled in it for a much longer period than can be done by any other culinary process. Cassareep was originally an Indian preparation, and has often been described, with more or less accuracy. It is well known that some of the Dutch planters of British Guiana have, by means of the addition of a

small quantity of cassareep, from time to time, to varieties of animal food, been enabled to keep up, in daily use, the same pepper-pot for many years.

A new kind of grease, made from rape oil, is now manufactured at Leipsic. The mass of grease or fat is quite pure, without taste or smell, and, according to medical certificates, contains nothing in the least injurious to health. In cooking it is stated to answer fully the purposes of butter, with the advantage that, instead of the usual quantity of butter, one third of this rape-seed grease will suffice. It may do for the fish friers, but as the butter ordinarily sold in London is bad enough, in all conscience, I trust that, for edible purposes, the rape grease may be kept by our German friends for their own use.

In several countries gum is eaten as a kind of makeshift for other food; but some kinds are nutritious. Thus, during the harvest of gum arabic, which lasts about six weeks, commencing in the middle of December, the Moors of the desert live almost entirely on gum arabic, and experiment proves that six ounces are sufficient for the support of a man twenty-four hours.

The white mangrove (*Avicennia tomentosa*) exudes a kind of green aromatic resin, which used to furnish a miserable food to the natives of New Zealand. A kind of gum, called by them djembar, is eaten by the aborigines of Australia. The gum of a species of acacia, called by the natives of Western Australia menna, is sometimes prepared by being first pounded, then mixed with spittle, made into a ball, and finally beaten into a flat cake, when it is kept by the native

as a provision against a time of want. Moore tells us it is considered good, and found to be very nourishing. The gum of the wattle tree Mimosa, the galyang of the natives, is eaten by them. It is soluble in water, and is one of the best gums in Australia for all common purposes.

In Russia a gum, called Orenburg gum, issues forth from the common larch during the combustion of the medullary part of the trunks when the forests are burned, which often takes place, either by accident or intentionally, during the warmer summer months. This gum is very glutinous, and, possessed of a sweet pleasant taste, is used as a substitute for gum arabic, and also for food.

There is no accounting for taste, even among civilized men, for Hogg, in his life of Shelley, tells us that—"Shelley used to pick the turpentine off fir trees, and eat it with a relish, or in walking through a pine wood, he would apply his tongue to a larch, and lick it as it oozed in a liquid state from the bark. I never met with any one else who had the same taste. I have expostulated with him on the subject, and, of course, in vain; and I once related to him a little apologue, which was rather more efficacious. I was once at a ball, a very pleasant one it was, and we were all dancing away merrily, but we were obliged to desist, for all on a sudden the fiddlers stopped in the middle of a tune; we told them to play on, but they answered, 'We cannot; we cannot go on with our music, because that rascal, Bysshe, has eaten up all our rosin!' Sometimes, when he was creeping stealthily up to a fir tree, that he might lick it, my fable of the

poet and the fiddler would come into his head, and he would turn aside laughing. The broken-up ball, the interrupted country-dance, the enraged musicians, the whole scene appeared in a moment before his eyes."

The cotton plant yields, besides its wool or lint, other valuable products which have recently been brought into notice, viz., a pure bland oil, equal to that of the olive; an oil-cake most excellent for feeding stock, and a fibre from the bark of the plant which may probably become of great importance. It is very desirable that these auxiliary products should be borne in mind, for in all calculations of produce from a cotton plantation, they seem to have been almost entirely ignored hitherto, although some well-informed authorities seem to consider that, in many cases, they may possibly yield as large a money return to the planter as that from the cotton itself. Even in the United States, which produce annually some 3,000,000 to 4,000,000 bales of cotton, it is but recently that this valuable character of the seeds has been partially turned to profitable account; hence we find that very few planters have yet availed themselves of the pecuniary advantages derivable from this source. It is generally calculated that short staple, or upland cotton, yields from two to three pounds of seed to each pound of ginned cotton, whereas long staple cotton gives a much greater proportion of seed. In the rich lands of Alabama, Louisiana, Mississippi, &c., the short staple seldom gives, on an average, less than three pounds of seed to the pound of cotton wool. According to the following statement by Mr. Woodall, confirmed by Mr. W. P. Converse and Dr. Jenner Coke,

published in New Orleans, an increased value of £5,000,000 or £6,000,000 sterling might be given annually to the cotton crop of the United States by utilizing the cotton seed, which is now almost wholly wasted. Taking the average cotton crop at 3,000,000 bales, of 400 lb., this would give 1.200,000,000 lb. of ginned cotton, yielding three times that weight of seed.

Now, supposing half this quantity retained for sowing, including waste, &c., there would be left for making oil, feeding cake, and soap, 1,800,000,000 lb. 100 lb. of cotton seed will yield two gallons of oil, equal to that of Italy, termed "salad oil," and it sells in New Orleans at 4s. per gallon, whilst in New York it fetches 6s. per gallon; 48 lb. of oil-cake (equal, or superior to linseed cake), and $6\frac{1}{4}$ lb. of soap stock, which, with ingredients of small value, will make 20 lb. of soap, equal to the best European kinds.

The following, then, is a moderate estimate :—

| | |
|---|---|
| 36,000,000 galls. of pure oil at 75 cents | £5,400,000 |
| 864,000,000 lb. of oil-cake at 1 cent .. | 1,728,000 |
| 106,000,000 lb. of soap stock at 3 cents | 636,000 |
| Total estimated value...... | £7,764,000 |
| Or, allowing a deduction of one-third to satisfy all objections .......... | 2,588,000 |
| Leaving a gross amount of.. | £5,176,000 |

It will be remarked, that in this statement the value of the fibre obtainable from the bark of the plant has not even been mentioned, but that it may be utilized there can be no doubt, and some opinion may be formed of the importance which this product

may hereafter attain, seeing that there are certainly seven millions of acres now under cotton culture in the United States alone, besides the quantity raised in Brazil, Egypt, Africa, and India.*

The chemical researches of Dr. Jackson, of Boston, Professor Shepherd, of South Carolina, Professor Anderson, of Edinburgh, and others, all go to prove that cotton seed may be profitably employed in the production of a rich oil, of a bland, pleasant taste, possessing all the qualities of olive oil, which burns with great brilliancy, and is peculiarly fitted for lubricating machinery, on account of not gumming or drying.

The woolly fibre adhering to the hulls might be economized in the manufacture of paper, while the marc or substance of the seeds could be more generally employed for feeding animals, and also as an excellent fertilizer. It is extensively employed in the Southern States as a manure for Indian corn, for which it is found useful. There cannot be less in all the cotton-growing countries than $1\frac{1}{2}$ million tons of seed available annually for agricultural and commercial purposes.

Cotton-seed cake is now exported largely from the United States to the Mediterranean, and it is imported to a small extent into this country from several American ports, in round cakes from Ohio, Boston, Albany, and other quarters, and the finest is imported packed in barrels. Analysis shows that these cakes are characterized by the presence of a larger proportion of oil than is usually met with in oil-cake of European manufacture, and the quality generally is good.

* Wray in Journal of Society of Arts, vol. vii. p. 78.

The oil varies in these from 9 to $10\frac{1}{4}$ per cent., and the albuminous compounds fluctuate between 26 and 31 per cent. From the relative proportion of these two most important constituents, cotton-seed cake holds a very respectable place compared with other oil cakes as a food for cattle. Cattle do not take readily to the cake at first, but eventually they get to like it, and thrive upon it. It can be used profitably as a substitute for seed-cake if the price be not too high. The stearine and slime from the oil make the best kind of soap for woollen and other goods, and either the hard or soft soap made from it is found excellent for fixing Turkey red and other difficult colours. Opinions differ as to its fattening properties for sheep, compared with linseed cake, but the much lower price at which it can be sold (nearly one half) is certainly a very material consideration. In many parts of India cotton seed is a distinct and important article of commerce, and the seed is given as food to the animals employed in ploughing and cultivating the land. It is usually taken on board home-bound ships, with grain, as food for milch cows.

The number of seeds found in one capsule varies in different species of cotton from five to twelve. As yet only the smooth black seed has been much used for pressing oil from, the downy seed resisting the action of the machinery; but improved machinery has been made to overcome this difficulty. Those who are at all acquainted practically with cotton know, that in some varieties the seeds are free, oblong, black, and without any other pubescence than the long, fine, easily separable, white wool; in others the seeds are

free, clothed with finely adhering greyish down, under the short staple white wool; while, in a third kind, the seeds adhere firmly to each other, so as to form a clustered mass, resembling a kidney, black, and free from every pubescence except the long white wool, which is easily removed.

By machinery in the United States and on the Continent, the cotton surrounding the seed is taken off, and can be sold to carpet manufacturers and papermakers. At Antwerp, it realises about 12*s.* 6*d.* to £1 the cwt.

Waste paper clippings and cuttings are bought up at from 1*s.* 6d. to 7*s.* 6*d.* per cwt., for common, up to 21*s.* per cwt. for the best clean white; such as the trimmings of bookbinders, envelope-makers' cuttings, the shredding from the plough-knife in cutting post and foolscap, &c. The best is worked up again for white paper, and the more common and coloured do for packing-paper and paper-hangings.

Cotton waste is the refuse cotton of the mill, being the "strippings" from the cards after the cotton has passed through the machine, the "flyings" or the portions which fly off from the card whilst the machine is in motion, the "droppings" and "blowings" which collect under the blowing machine in which cotton is cleaned, and the "sweepings" or gatherings from the floor of the card-room. The value of cotton waste varies with the price of cotton; strippings and blowings are worth about one-half to two-thirds that of cotton; and droppings, blowings, and sweepings, one-tenth to one-eighth.

The waste of cotton made during the process of manu-

facture is, according to Mr. Ashworth, wrought into coarse sheets and bed-covers, which are sold at prices varying from 6d. to 9d. per lb. The residue of the waste is used for the manufacture of paper, the cleaner portion being for writing paper; the sweepings from the floors of factories supply a large proportion of the paper-mills of Lancashire with the raw material of the paper which is used for the printing of books and newspapers. The actual quantity of waste made must be very considerable in this country upon a consumption of 900 or 1,000 million pounds of cotton annually.

Estimating it at 15 per cent., the usual allowance, there must be at least 60,000 tons of cotton waste available, which, added to 20,000 tons of linen waste, and the same quantity from rope and canvass, gives a large quantity to be worked up again. Previous to 1841 cotton waste was only used for making very common papers, but straw pulp being more generally used now for this purpose, cotton waste is chiefly worked up for printing-paper.

There are in Oldham 127 cotton-waste dealers; in Manchester, 82; and in other towns in Lancashire, 244; so that probably 500 cotton-waste dealers may be set down. In America waste cotton is employed for the manufacture of furniture, after the manner of papier mâché; it is compressed into imitation wood which takes a very beautiful polish.

The quantity of oakum sold in Liverpool, we are told, amounts to 1,400 tons a year, valued at £28,000, and the quantity used in London no doubt exceeds this, looking at the extent of shipping and the other

uses to which it is applied. We exported 257 cwt. of it in 1860.

Of codilla, or tow, the refuse or waste fibres knocked out of hemp and flax in cleansing and carding it, we imported in 1857 nearly 13,000 tons, valued at £373,000. It is made into bags, sheeting, and yarn, and used for other purposes.

In 1860 the imports were of—

| | Cwts. | | Value. |
|---|---|---|---|
| Tow and codilla of flax . | 166,534 | .. | £337,942 |
| ,, of hemp | 16,424 | .. | 23,911 |
| | 182,958 | | £361,853 |

The seeds or stones of many fruits, which would apparently seem useless, have some economic value. I speak chiefly of those which are often thrown away, passing over many that are applied to ornamental uses, the enumeration of which would carry me too much into detail. In certain parts of Egypt the date stones are boiled to soften them, and the camels and cattle are fed upon them. They are calcined by the Chinese, and said to enter into the composition of their Indian-ink. In Spain they are burnt and powdered for dentifrice, and vegetable ivory nuts are said to be applied for the same purposes. Some species of Attalea nuts are burned, in Brazil, to blacken the raw eaoutchouc or India-rubber.

The seed or stone of the tamarind is sometimes prescribed in India in cases of dysentery, as a tonic, and in the form of an electuary. In times of scarcity the poor natives eat them after being roasted and

soaked for a few hours in water; the dark outer skin comes off; they are then boiled or fried. An oil has also been obtained from this seed. The albuminous seed of *Morinda bracteata*, the bean of *Inga doneean*, the acorn of *Castanea indica*, and the seed of the jack fruit (*Artocarpus integrifolia*), when roasted, form articles of food. The seed of the Carob-bean (*Ceratonia siliqua*), is ground up as food for cattle, and is used in Algeria, when roasted, for coffee.

In France and Germany an oil is extracted from beech-mast, the seed or fruit of *Fagus sylvaticus*, next in fineness to that of the olive, and which may be preserved longer than any other oil. But they seem to furnish little oil in northern countries. A bushel of mast will yield about a gallon of oil. In some parts of the Continent this oil is used instead of butter for ordinary purposes. Hogs fatten rapidly on beech-nuts, but the pork is not esteemed. Roasted beech-nuts form a tolerable substitute for coffee; and before the general use of corn they were, like acorns, the food of uncivilized man; dried and ground into meal, they make a wholesome bread.

In England the sweet chestnut is not so much used as it is in Europe. Evelyn speaks of the chestnut as being "a lusty and masculine food for rustics at all times, and of better nourishment for husbandmen than kale or rusty bacon; yea, or beans to boot." In the south of France and the north of Italy chestnuts serve, in a great measure, as a substitute for bread and potatoes. The nuts laid by for winter vegetables are those which fall from the trees, while those which are beaten off are carried to Paris and other large towns

for immediate use. As a means of depriving the nuts of their husks, they are trodden under foot by men wearing *sabots*, or wooden shoes. Chestnuts are kept in France for many years ; they are dried by the air, by the sun's heat, by a kiln, or by partial boiling, according to the mode in which they are to be used. The French make many dishes from them. *Galette* is a thick flat cake, made with chestnut meal, with salt, and sometimes a little butter and eggs, and baked on a hot stove or iron plate. *Polenta* is a thick porridge, made by boiling the chestnut meal in water or milk, stirring it till it forms a thick paste, something like the oatmeal "parritch" of the Scotch. *Chatigna* is made by boiling the nuts whole, without their skins, in water with a little salt, till they become soft, and then mixing them up like mashed potatoes. *Marrow glacé* is made by dipping the nuts into clarified sugar, and then drying them. The nuts are also frequently cooked by boiling them in water containing the leaves of celery or sage. The dried chestnuts of the Apennine forests produce fine flour, as soft as velvet, and nearly as sweet as sugar. 350,000 quarters of chestnuts are consumed annually in Sardinia. Périgord is the region of chestnuts, there being in the department of the Dordogne above 100,000 hectares of that tree, and in the Corrège and Upper Vienne 130,000 hectares. If we take in the neighbouring departments, it constitutes a wide band crossing France, and containing 500,000 hectares (1,250,000 acres) of chestnuts. It is the tree *par excellence* of the mountain districts, where the climate is not too cold and subject to the early spring frosts. This fruit furnishes

a hundredth part of the national aliment; although it is reckoned superior, weight for weight, to the potato, those who live on it are not strong; but eaten with milk or cheese it forms an agreeable food. Walnuts also are a notable production of Périgord, their annual value being estimated at nearly a million francs.*

When first introduced from Constantinople, the fruit of the horse chestnut was considered edible; and Parkinson, writing in 1629, included it among his fruit-trees, and described the nut as of "a sweet taste and agreeable to eat when roasted." Very little use has ever been made of the nuts in this country; though in Turkey they are mixed with horse food, and are considered good for horses which are broken-winded. When ground into flour, they are used in some places to whiten flaxen cloth, and are said to add to the strength of bookbinders' paste. They contain, moreover, so large a quantity of potash, as to be a useful substitute for soap, and on the latter account they were formerly extensively employed in the process of bleaching. The nuts contain a great deal of starch. Various attempts have been made to utillize them by producing sugar and spirit from them, and on removal of the bitter principle, excellent edible fecula and maccaroni has been made from horse chestnuts in France.

"Fecule de marrons d'Inde" is now made by H. de Callias, 18, Rue de Bellevue, Passy, near Paris, and sold at 22 francs the kilo. The process adopted by this

* Quarterly Journal of Agriculture.

maker permits the purifying of the fecula without having recourse to the peeling which was formerly considered indispensable, and hence the extraction of the starch is as easy and cheap as that from the potato. The following is given as the cost :—

| | Francs. |
|---|---|
| Collection of 20,000 kilogrammes of horse-chestnuts in the park of St. Cloud ...... | 400 |
| Conveyance to the factory of the Abbey du Sal, belonging to M. Becappe .......... | 280 |
| Manufacture and total other charges ...... | 200 |
| | 880 |

Horse-chestnuts are much used on the Continent, especially in the Rhine districts, for fattening cattle and for feeding milch cows. Hermstadt gives the following analysis of a sample dried in the air, and with 21·8 per cent. of the shell removed :—

| | |
|---|---|
| Starch .. .. .. .. .. | 35·42 |
| Flour fibre .. .. .. .. | 19·78 |
| Albumen .. .. .. .. .. | 17·19 |
| Bitter extract .. .. .. .. | 11·45 |
| Oil .. .. .. .. .. .. | 1·21 |
| Gum .. .. .. .. .. | 13·54 |
| Total .. .. .. | 98·59 |

Pabet estimates that 100 lb. of dried horse-chestnuts are equal in nutritious value to 150 lb. of average hay; another authority, Petri, makes them equal, weight for weight, to oatmeal.

There is a large trade carried on in the cupules or acorn cups of a species of oak, the *Quercus Ægilops*, growing in Turkey and Southern Europe. These are

imported, under the name of "valonia," to the extent of about 20,000 tons annually, for the use of tanners. In acorns, however, we carry on no commerce, but they have their uses. Under the name of "bulloot," the acorns of *Quercus incana* are sold in the bazaars of India as a medicine. Kampfer says there are two species of oak peculiar to Japan, the acorns of which are boiled and eaten.

There was a time, in days gone by, when acorns were extensively used as food. Acorn-bread was much eaten both by the Greeks and Romans, and our Saxon ancestors reckoned acorns as an important article of food, especially in years of deficient harvest. The holly-leaved and some other species of oak produce very fine and sweet acorns. *Q. gramuntia* and *Q. Ballota* furnish the choice bellotes which Teresa, the wife of Sancho Panza, gathered in La Mancha, where they grew in the greatest profusion, and sent to the Duchess, wishing, instead of their being only the best of their kind, that they were the size of ostrich eggs. In Greece, Asia Minor, and Barbary, acorns are sold in the streets as food. and are eaten both raw and roasted. The late General Jackson, of the United States, once sent his officers an invitation to a breakfast on acorns, at a time when provisions were scanty. Tolerably good bread may be made from acorns when shelled, and especially if allowed to germinate before being used, so that part of the farina may become converted into sugar. Some persons who have tasted such bread are of opinion that it is very little inferior to oat bread. A French chemist has recently tried this. He takes the acorns,

hulls them, and boils them in a weak solution of carbonate of soda for about half an hour. They are then taken out and washed. This removes the astringent taste from them, after which they are dried and ground into flour. Mixed with an equal quantity of wheat flour, it makes a palatable and nutritious bread.

Bryant, in his "Travels in California," tells us that a loaf made of pulverized acorns, mingled with wild fruit of some kind, was set before him by the Indians. I do not know what effect acorns or acorn-bread may have upon the human subject, but an old historical ballad tells us that pigs get very jovial and riotous upon acorns.

> The hog he munch'd the acorns brown,
> Till joyfully twinkled his tail,
> And he twitched himself up, and he tossed himself down,
> And he wriggled and reeled, and galloped and squealed,
> As though he were drunk with ale :
> For you shall know that what by ale or wine
> To man is done, that acorns do to swine.
>
> *Edwin the Fair, an Historical Drama.*

With the extended culture of land, and the great progress of agricultural improvements, we are now able to leave such common fare as beech-mast and acorns as food for swine.

In Turkey acorns are buried for some time in the earth, by which the bitterness is destroyed. They are then dried and toasted. Their powder with sugar and aromatics constitutes the *palamoud* of the Turks, and *racahout* of the Arabs, an alimentary substance readily digestible, and very much esteemed.

But there is one other use for acorns which may be unknown to many, and that is, for making a coffee substitute, vended in France under the name of "*café de gland doux*," which is thus eulogized by its vendors :—

"Acorns were for a long time the principal food of man. The oaks which grow in Central Europe (*Q. Suber*, *Q. Ilex* and *Q. Ballota*) bear a fruit of a sweet flavour, agreeable to the taste and very nourishing.

"Although now-a-days acorns do not supply the place of bread, their beneficial properties have not the less occupied the attention of scientific men who study health. It was sought to present them in a form suited to the habits of the age, and this was obtained by torrification, whence we have acorn coffee.

"Colonial coffee (*café des îles*) owes its success to the aroma it possesses and its exciting action on the brain. Acorn coffee possesses these properties in a more permanent if less marked form : the former seems to reanimate momentarily the strength by a kind of febrile agitation ; the latter restores by its tonic action on the stomach and the digestive organs, affording to the nourishing vessels a fortifying principle, which restores by its continued use the vigour and energy of all the organs. It is by studying the effects of this new aliment that we have been able to demonstrate that its daily use regulates the natural functions, restores the health and plumpness of persons weakened by long illness or excessive labour, reanimates the strength of debilitated children and weakened systems. It is made by Hayet, and sold in packets

of 250 grammes, or half a pound, at 50 centimes (about *5d.*)."

The ochro plant (*Abelmoschus esculentus*, W. & A.) is much cultivated and used in tropical countries for its mucilaginous capsules, which, in a fresh state, are used for soup; the mucilage given off enriches the soup materially, while the less soluble portions are softened, together with the seeds, and produce an admirable potage. It passes under various names in different countries. The "gumbo" of the Southern States of America, and the "pepper-pot" of the West Indies, are made with it. The consumption of this plant has materially increased in North America; some farmers in New Jersey grow seven or eight acres of it annually. The plant is called bendi-kai in India. The young pods are gathered green and pickled like capers. They are sometimes preserved dried for use, and it has been suggested that if pulverized the powder might become an article of commerce for thickening soups. When the plant is suffered to ripen, the seeds are large and hard, and the amount produced is very great; when roasted, they produce an imitation of coffee scarcely inferior to the true berry. The young seeds may be boiled like barley, and the mucilage which they contain is both emollient and demulcent. The leaves are used for poultices. The plant yields a silky fibre, strong and pliant, and well suited for the manufacture of ropes, strong gunny bags, and paper. It is perfectly evident to those who have examined it, that neither the aloe, the beechwood, ordinary straw, nor any of the substances now being made use of in place of cotton or fibre for paper, can surpass it for this

purpose. The fibres are exported to a slight extent from India as hemp, to which they bear a considerable resemblance. A bundle of them tested by Dr. Roxburgh bore a weight of 79lb. when dry and 95lb. when wet.

In the cider districts quantities of pommage, commonly called *pummis*, collect around the cider-mills. The malic acid contained in the pommage in its first state is very deleterious to vegetation, but if the marc be mixed with one-tenth part of its bulk of ashes, the acid is neutralized, and the mixture rendered an active manure. Dr. Gesner, in his work "On the Industrial Resources of Nova Scotia," states that he raised 300 bushels of ruta baga from one quarter of an acre of land manured with pommage and ashes that had lain eight months in compost.

The marc, or husk, of the grape in wine-making is put to various uses. In some vineyards it is thrown into casks and covered with water, which filters through the mass and extracts the remaining juice. In this case it does not undergo the last pressure, and produces a weak drink for the labourers. When the husks, &c., are fermented in the tun (in which they are deposited after the wine is cleansed, along with the lees and other impurities) they are pressed and made into small wine in the same manner, provided they show no signs of acidity; if they do, the *pressures* are made into vinegar. In some provinces, the marc, when completely exhausted of its juice, is preserved, to be afterwards dissolved in warm water and mixed with straw, turnips, &c., and eaten by cattle and horses. In other parts it is burnt for the

sake of its alkali.* The charred husks of the grape and residue of the wine-press are used for making black colours, or the choice ink used in copper-plate printing.

Rape, or the refuse raisin stalks and skins left after making British wines, are used by vinegar-makers, the vinegar being filtered through the mass in large wooden vessels.

The marc from the ground nuts (*Arachis hypogæa*), after oil-pressing, diluted with water, furnishes an amylaceous matter, which is mixed with pastry, and enters into the common cocoa or chocolate of the poor Spaniard.

In many places where the date-palm flourishes, the stones are ground to make oil, and with the paste that is left they feed the camels and sheep. This is practised chiefly on the coast of Arabia, in the Persian Gulf, and at Muscat, where they find it a very nourishing food.

The palm-oil of commerce, which is now imported to the extent of 42,735 tons a year, is entirely made from the sarcocarp, or fibrous pellicle that surrounds the nut; the kernels, with the exception of an insignificant quantity used for the manufacture of oil for domestic purposes in Africa, were formerly thrown away. Within the last few years, however, they have been utilized, and, the shell being broken, the kernels are shipped to be pressed for oil, and a vast extension of the African trade has arisen out of this new article of export.

Mr. C. Heddle, a leading merchant of Sierra Leone, a reliable authority, furnishes some useful data as

* Booth on "Wine-making."

to this new export. The 50,000 tons of palm-oil shipped from Western Africa would leave, he estimates, 10,000,000 bushels of kernels, equal to 223,000 tons. The average yield of oil from these kernels being 30 per cent., the 223,000 tons would consequently furnish 76,000 tons more of dark oil, worth at the present price of cocoa-nut oil (which it closely resembles in all its properties) nearly £3,440,000. If we add to this the value of the cake—112,000 tons, at the very low price of £5 per ton—we should obtain £560,000, making the whole gross value upwards of £4,000,000, or three-quarters of a million above all the tallow imported into this country; obtained too from a formerly waste product. The waste liquors of soap and stearine candle works are now converted into that valuable substance, glycerine. Oleic acid also takes the place of olive-oil in preparing wool, and the other residuums are applicable to various purposes. The cake or marc of the olive remaining after the oil is expressed, is used in Sardinia, Italy, and other districts for manure and for cattle food. The poonac or refuse pulp, after pressing oil from the cocoa-nut, is also a valuable fertiliser.

The walnut is the olive of Savoy, supplying the inhabitants with oil not only for home consumption, but for export to France and Geneva. The kernels are crushed by a mill into a paste, which is pressed to extract the oil, and afterwards dried in cakes, called *pain amer*, which are eaten by children and poor people. About 1,200,000 pounds of walnut kernels are annually consigned to the oil-press in Cashmere, yielding about half their weight of oil; the other

half cake, which is much valued as food for cows in winter, is usually exchanged for its weight of rough rice.

The various oil-cakes which are prepared in England, or imported from abroad, are a utilization of waste substances of a very important character. They enter into commerce for feeding cattle and for manure. Of these, rape, linseed, and cotton-seed cake are the principal; but all the marc or cake from the oil-mills, whatever seed is crushed, is useful to some extent. Our imports of oil-cake have largely increased, reaching now 100,000 tons a year!

It appears that there is an article manufactured in the neighbourhood of Liverpool, called *shude*, of the value of £3 per ton, and supplied to many oil-crushers to mix with linseed-cake, to the extent of 30 per cent. and upwards. It is made from the husks of rice and the refuse of rice-mills. It is perfectly tasteless and yields no nourishment. Its colour and price make it a favourite article, and in great demand with dishonest crushers to mix with cake. One grinder of shude has sold to oil-crushers during a period of nine months nearly 2,000 tons.

In cleaning paddy or rice, the rough silicious outer covering, which is impervious to water, forms a useful litter for stables, and material for packing crockery-ware or ice, instead of sawdust. There is also separated in the process of husking a bran or fibre, covering the white rice, which is a most excellent food for horses, milch cows, pigs, and poultry. The uses for chaff I need not allude to.

The husks of buckwheat are used for packing.

The bran or exterior husk of wheat in the process of grinding and bolting for flour, besides its nutritious properties for feeding, has commercial uses in tanning, in calico-printing, for stuffing dolls, filling cushions, &c.

A writer in a Jamaica paper thus speaks of many of its undeveloped products :—

"There are few individuals, perhaps, in the country who have given themselves the trouble to consider what are the minor productions which might, to a limited extent in each case, be made articles of commercial value, if duly prepared for export. We observe, for instance, among the cargoes exported from Black River and Savanah-la-Mer, several casks of 'orange-peel.' Now, it does look very absurd to find people packing orange-peel, which we are in the habit of throwing out of window for the use of such pigs and goats as walk at large in defiance of police laws, into barrels for shipment all the way to England ; and yet we may be assured that the individuals who have taken all this trouble have not done so without first assuring themselves that orange-peel was a saleable commodity in England, and that its value was sufficient to repay the cost of collection in this country, together with freight and other charges. The value of a few casks of orange-peel must, of course, be extremely small ; yet it answers some one's purpose to collect and export it. If he only realizes a ten-pound note by the transaction, he imports that value into the island in exchange for a commodity which would be otherwise of no use whatever. If one hundred persons were at the same trouble as him-

self, they would increase that value to a thousand pounds. Now, orange-peel may be considered an extreme instance of the commercial value which attaches to trifling articles that abound throughout the island, but which few people will take the trouble to prepare for market because they are minor in character and value.

"The quantities of honey and bees'-wax actually exported from Jamaica bear a very inconsiderable proportion to the quantities produced, whilst these are articles of ascertained commercial value, Jamaica honey being considered only second to the highest flavoured Italian qualities, provided, of course, it be run from young combs, and put up carefully for exportation.

"Lime-juice, prepared in a concentrated form for the manufacture of citric acid, is an article of very high intrinsic value; and any one who takes the trouble to prepare and ship it in any quantity might make the business an exceedingly productive one. We all know how universally the lime grows throughout the island, and by what simple and inexpensive machinery the juice may be expressed. To prepare this juice for market involves but a very small amount of labour or expense. It may be done in two ways: either by boiling the juice until reduced by evaporation to a dense syrup, in which state it may be transferred to casks for shipment; or by converting it into *citrate of lime* by addition of powdered chalk in sufficient quantities to the fresh juice, decanting the supernatant liquor, and drying the precipitated *citrate.* The lemon-juice used in the preparation of citric acid in

England is principally imported from Spain and Portugal in the former of these conditions. A very large manufacturer, whose works we visited near Blackwall, assured us that he would give fifteen guineas for every pipe of this concentrated juice that might be shipped to him from Jamaica. That was in 1852, when the prices of all these raw materials were considerably less than at present. Surely, it would not cost half so much to prepare a pipe of concentrated lime-juice as it would to produce and manufacture a hogshead of sugar; and yet the value of the former is considerably greater than that of the latter at present market rates. Some individual who has thousands of lime-trees on his estate, producing nothing merchantable, may find it answer his purpose to try and convert them to a valuable purpose in the way we have suggested.

"There are hundreds of other products which could be mentioned, all of which might be made available to a limited extent, and would well repay those individuals disposed to lay themselves out specially for their production and manufacture. We might supply the markets of the world with castor-oil of the finest and purest quality; but we actually prefer to import and consume an adulterated compound made up in the shops of the London chemists under the name of 'Cold-drawn *East* India castor-oil.' The same thing may be said of cocoa-nut-oil, and of many other vegetable oils, which all possess a high commercial value, and may be prepared at a very inconsiderable expense of labour or capital."

Another recent utilization of waste is that of old

vulcanized india-rubber, for which a company was formed in February, 1862, with a capital of £75,000.

Until very recently it was supposed that india-rubber once vulcanized and manufactured could not be brought into a state by which a re-manufacture would be possible, and consequently articles manufactured from vulcanized india-rubber and rendered useless either by wear, injury from abrasion, or by some accident in the process of manufacture, have been treated as worthless. Vulcanized india-rubber being now an article in extensive use in engineering and manufactures, the supply of the worn or damaged material is very abundant.

After a large expenditure of money, and much scientific research, it has at length been discovered that the old vulcanized rubber can be reduced into a plastic condition, and fitted for re-manufacture into the majority of the articles to which it was applicable in its original state, by very simple means, and at very slight cost; these results have been embodied in patents, dated July 30, 1858, 2nd November, 1858, and 23rd May, 1859, for "Improvements in treating Waste Vulcanized India-rubber." These inventions have been carried into highly successful practice by two of the largest companies in the United States, viz., the New York Belting and Packing Company, and the Beverley Rubber Company.

Mr. Hall, the inventor of the patented process, formerly manager of the last-named company, and a thoroughly practical manufacturer of large experience, has been engaged by the directors of the new company as their manufacturing manager.

The prospectus states that "the manufacture of vulcanized india-rubber in Great Britain has not hitherto supplied any very large portion of the demand for the article, and the manufacturers have, with scarcely any exception, been commercially successful.

"It is intended to commence the works with the manufacture of articles all of which are connected with engineering, mechanical, and manufacturing purposes, such as mill-banding, packing, valves, washers, discs, hose and tubing, tarpaulings, rickcloths, floorcloths, &c., these being in most steady demand, and at most remunerative prices. All the above manufactures can be produced by a mixture of about 70 per cent. of the waste material, and 30 per cent. of the raw gum: the waste material being obtainable at from £17 to £18 per ton, whilst the raw gum, taken at the very lowest quotations, sells at from £150 to £200 per ton, according to its quality. As one of the largest items in the cost of production of all the above articles is that of the caoutchouc gum itself, it is obvious that there must be a large excess of profit from working the company's patents over that derived from the use of the pure gum, from which the articles now in the market are manufactured."

The quantity of crude caoutchouc imported into the United Kingdom in 1859 was 43,039 cwt., valued at £470,518; and of manufactures of india-rubber 1,040,809 lb., valued at £74,952. The consumption in the North American States is much larger than with us.

## PAPER MATERIALS.

MANY attempts have been made from time to time to furnish new raw materials for paper, but hitherto with only partial success. The failure, according to Dr. Playfair, generally results from one or more of three causes: 1. Some fibres require so much cost to bring them to the state in which they are offered to papermakers, in the form of rags or cotton waste, that in point of economy they cannot enter into competition with the latter; 2. Certain fibres lose so much weight in bringing them to this state, that they cease to be economical; 3. Certain fibres, which are well adapted on account of their texture for the paper trade, present so many difficulties in bleaching them as to render them unfit for white paper. The Surat bass, in which cotton has of late years been imported into this country, offers an example of this difficulty.

The price of 2*d.* to 2½*d.* per lb., which was mentioned in a Treasury letter lately issued for a partially-prepared pulp, is generally considered by most makers to be too high; they think that materials to be of benefit should be looked for at the price of 1*d.* to 1½*d.* per lb. The latter price refers to roughly-prepared pulp; but should the pulp be offered in a bleached state, or in as far an advanced state with regard to colour and texture as cotton or linen rag, then 2½*d.* to 4*d.* per lb. might be obtained. The quantity of any promising material sent home for experiment should not be less than half a ton in weight.

At one of the recent Exhibitions of the Society of Arts, a case of vegetable fibres for paper-making was shown, consisting of straw deglutinated and fibred, but not bleached; secondly, half bleached and fibred; thirdly, the same straw brought into a pulp, so as to require to be placed in the beating engine but a very short time, thereby effecting a considerable saving of time and mechanical labour. There was also exhibited new jute, and gunny-bag, or old jute bleached and partially pulped,—a red bark from the East Indies, called by the natives Lituria Bark,—sugar-cane trash, or the refuse crushed stalk after the saccharine has been extracted, and vegetable silk or silk cotton. These were not shown as new materials for paper-making, because paper was made from straw in Germany in the year 1776; in Belgium from wood, grass, reeds, moss, &c., in 1786; and Matthias Koops took out a patent in England for making paper from straw in 1800. Du Halde tells us that paper was made in China from the bark of trees by a mandarin of the palace in the 95th year of the Christian era.

They were exhibited to show that they were really fibrous materials, from whatever vegetable produced, when prepared by the inventor's process, and not mere pasty pulps, as the greater part of such materials are when prepared by other processes, and therefore fitted to make papers of much greater strength and durability than paper from such materials usually possesses when brought into the market. The inventor's method of preparing the pulp is one-third to one-half less than the actual cost incurred in paper-mills generally in preparing such substances.

The sugar-cane trash is admirably suited for the manufacture of fine papers of great strength and beauty, whilst, on account of the other rich matters obtained therefrom, the cost of such paper would actually be £5 per ton less than the common white straw paper.

The silk cotton, on account of its price, cannot be employed as a paper material; but should it ever be introduced as a fabric or material for female dress, it would then, as a worn-out article, become a valuable addition to paper-making substances.

That there is a war of prices now raging in the printing world between the producing and consuming interests is a fact which for some time past has been obvious to every observer; and indeed has been, to a certain extent, felt directly or indirectly both by publisher and purchaser; it is, moreover, indicated to the latter by the alteration in quality of the material on which newspapers and other periodical works are printed. Little did the *Times* conceive, when advocating so warmly the extension of cheap literature and railway reading for the million, how soon the public appetite, which grows apace by that on which it feeds, would create a literary famine in the land. The ravenous maw of the insatiable printing press is never satisfied, and the cry is still, "give, give," whilst the paper-makers are at their wits' end for raw material. With the reduction of the excise duty from 3*d.* to 1½*d.* per lb., the average annual make of paper increased more than cent. per cent.; namely, from 70,988,131 lb. in 1830-34, to 151,234,175 lb. in

1849-53. The entire removal of duty has given a further stimulus to its manufacture and employment.

The quantity of paper manufactured in this country in 1858 was 182,847,825 lb.; in 1859, 217,827,197 lb.; in 1860, 223,575,285 lb.—a considerable increase in each year. So recently as 1848 the quantity was only 121,820,229 lb. The net produce of the duty was £1,103,754 in 1858, £1,258,464 in 1859, and £1,321,105 in 1860. The net produce of the Customs duty on paper imported into this country was £9,886 in 1858; £14,841 in 1859; and £27,236 in 1860. The paper duty brought in more than half as much as the income-tax on trades and professions at its original rate of 7*d.*

It is not alone in the mother country that the deficiency and increasing price of paper is felt. Our colonies, particularly the southern and western ones, derive their chief supplies of paper from England. In the Australasian settlements and the Cape colony newspapers have lately been increasing rapidly, both in number and circulation. In Sydney and Melbourne, the daily journals, of which there are now several, have a circulation, in some instances, of 10,000 to 15,000 per diem, and to the high wages they have to pay, in order to retain compositors and pressmen, is now superadded the difficulty of getting paper at any price. In South America the same dearth prevails, for in a Lima journal, not of the brightest texture, "Shipmasters and others who have on hand old unserviceable sails, or pieces of old sailcloth, white rope, &c., applicable to paper-making," are informed that they "can

dispose of the same for cash at a fair price per pound, by applying to the advertiser at Callao."

A strange feature in journalism is the gigantic strides which the *Times* has made; its average daily issue being 45,000 to 50,000 copies. As it always has a supplement (single or double sheet) and frequently an additional half sheet, its consumption must be, at least, seven or eight tons per day, and this is exclusive of the *Evening Mail*, its tri-weekly issue, which uses about 800 tons in a year. The enhanced price of paper to the *Times* is, therefore, a matter of serious moment; and we cannot be surprised at finding in its columns, a few years ago, an offer of £1,000 for any new material calculated to cheapen the cost of paper, by supplying a pulp which can meet the present deficiency of rags. The weight of material now required for the manufacture of paper in England has been computed at upwards of 130,000 tons.

There are now numerous journals of considerable circulation in the metropolis that, from the low price at which they are sold, have a deep interest in the price of paper, which, as it rises, trenches largely on their small marginal profits.

Vegetable substances which might be used for the cheap manufacture of paper abound in India and our colonies. The bamboo makes an excellent coarse paper, and is much used for that purpose in China, and the wood of all the hard convolvolus family is admirable for the purpose. Every tree on the river banks of British Guiana is festooned with the latter, and, by rolling them into bundles, they might claim as *dunnage* exemption from freight. The plantain yields an

abundance of fibre which is, for the most part, left to rot on the ground in the countries between the tropics. A good and constant supply for the London market could be obtained in almost all the British West-India islands, especially in Jamaica and Trinidad, and even at Porto Rico, Hayti, and Cuba; in British Guiana, along the Mosquito shore, the Central American republics, Brazil, and the settlements on the west coast of Africa. On one estate alone, in Demerara, it is stated, as an illustration of the waste that takes place, that 500 plantain trees on an average are cut down, for the sake of their fruit, on each working day throughout the year. Each stem contains 2½lb. of clean, and 1½lb. of discoloured and broken fibre suitable for the manufacture of paper, besides what might be furnished by the leaves and midribs. Hence it is seen that at least 600,000lb. of valuable produce are lost on one property out of many hundreds in the colonies of Demerara, Essequibo, and Berbice, through the mere want of requisite machinery and attention to turn it into utility.

In my work on "The Commercial Products of the Vegetable Kingdom," published some years ago, I stated that "The advantages to the paper-manufacturers in employing this prepared fibre instead of rags would be enormous, for the fibre is equal in texture, clean and aromatic, whilst rags are dirty, full of vermin, and often pestilential. A large stock of the plantain can always be secured without fear of its being injured by keeping. The paper will be superior to that made of rags, and the process of making it will be economical, inasmuch as the sorting of the material will

not be required. Another advantage is, that a new article of commerce will be opened for the benefit of the shipping interest, and a stimulus given to the cultivation of a fruit which is the favourite food of large masses of the population."

The *Athenæum*, of the 25th January, 1862, states that —" The enormous demand for paper, consequent on the repeal of the paper-duty, has led to the formation of a large company at Hilkstone, near Peterborough, for the purpose of converting couch-grass, or twitch, into pulp. Hitherto, the difficulties attending the use of vegetable substances for pulp have arisen from the great quantity of silica which they contain." In the same paper, Mr. Charles Reade, the novelist, in a letter alluding to the departure of his nephew for an exploratory tour in Western Africa, states that he suggested to him that any new material which could be floated to the coast, at a charge of three glass beads and a lozenge per ton, suitable for making paper of, might suit such of his friends as administer periodical instruction at the present time.

The following statistics of paper production in the States are from an American journal :—

"It is estimated that one and a half pounds of rags are required to make one pound of paper. Adopting these data, we find that 405,000,000 pounds of rag are consumed in one year; their value at 4 cents a pound being 6,200,000 dollars.

"The cost of labour is one and a quarter cents upon each pound of paper manufactured, and is, therefore, 3,375,000 dollars a year; and the cost of labour and rags united is 19,575,000 dollars a year.

"The cost of manufacturing, apart from rags and labour, estimated from adding together the cost of felts, wire cloth, bleaching powders, fuel, machinery, interest, and fixed capital, insurance expenses, &c., we find to be 4,050,000 dollars. Adding this to the cost of rags and labour, we find that 23,625,000 dollars is the total charge for manufacturing paper worth 27,000,000 dollars, a measure of profit by no means unreasonable; and which might even be considered small were not the manufacture comparatively free from those sudden changes that affect the manufacture of cloth and metals."

The value of the American exports and imports of paper, and imports of rags, from 1838 to 1858, have been as follows:—

| Year. | Exports Paper. Dollars. | Imports Paper. Dollars. | Imports Rags. Dollars. |
|---|---|---|---|
| 1838 | 91,333 | 164,179 | 465,148 |
| 1839 | 80,149 | 186,418 | 588,348 |
| 1840 | 76,957 | 46,090 | 560,689 |
| 1841 | 83,483 | 60,093 | 496,227 |
| 1842 | 69,862 | 92,077 | 468,220 |
| 1843 | 51,391 | 19,997 | 79,853* |
| 1844 | 83,108 | 104,648 | 295,586 |
| 1845 | 106,190 | 98,609 | 421,686 |
| 1846 | 124,597 | 194,220 | 304,216 |
| 1847 | 88,731 | 195,571 | 385,397 |
| 1848 | 70,507 | 410,668 | 826,607 |
| 1849 | 86,827 | 305,773 | 524,755 |
| 1850 | 90,696 | 496,563 | 748,707 |
| 1851 | 155,664 | 720,860 | 903,747 |

* Duty began to be enforced on rags, 1843.

| Year. | Exports Paper. Dollars. | Imports Paper. Dollars. | Imports Rags. Dollars. |
|---|---|---|---|
| 1852 .. | 119,535 .. | | |
| 1853 .. | 122,212 .. | 602,659 .. | 982,837 |
| 1854 .. | 191,843 .. | 757,829 .. | 1,010,443 |
| 1855 .. | 185,637 .. | 762,766 .. | 1,225,159 |
| 1856 .. | 203,013 .. | 726,552 .. | 1,239,168 |
| 1857 .. | 224,767 .. | | |
| 1858 .. | 229,991 .. | 557,664 .. | 971,126 |

There can be little doubt but that vegetable productions suited to supply the paper material and many other manufacturing wants, can be obtained from our numerous and wide-spread colonies; and it is not too much to invite the attention of practical and scientific men to this subject, as, apart from the minor profit that might be gained, any discovery in this direction would be a noble contribution to the world's progress.

The *Wellington Independent*, a New Zealand paper, writes :—" Complaints have been made in England of the want of material for making paper. Straw has been used for the purpose; but surely a much better paper could be made from our common flax and the leaves of the cabbage-tree (and quite as good, I should think, as that made of the old rags which have been hitherto used). Flax can be had, as we all know, in any quantity; the cabbage-tree is not so abundant; but there need be no lack of this, for, when a tree is cut down to get at the leaves, if the stem is laid in a shallow trench, and slightly earthed up, a dozen young plants will speedily spring from it, and the leaves may be cut in the following year. That these plants (the flax and cabbage-tree) will afford good materials for

making paper, I think there can be no doubt; but the question arises, what would be the best form in which to send them to England? This I cannot answer; but I think the subject well worth attention. Would not paper-mills in this country pay well?"

In a late Sydney newspaper mention is made of a peculiar vegetable substance, taken from the root of the *Zamia spiralis*, vulgarly known as the native palm. This plant, which flourishes luxuriantly over millions of acres of land in New South Wales and other Australian colonies, otherwise unproductive, seems to possess many properties which would render it highly valuable as a plant of commerce. The substance is a sort of cotton, very short in the staple, but fine and soft, and it would appear to be admirably adapted to the manufacture of paper. Experienced persons state that it would be preferable for this purpose to the refuse cotton of the manufactories of Lancashire, which is bought by the paper-makers at the rate of 6*d.* a pound. The specimen was collected at the Clyde River, near Bateman's Bay, and is described as forming a kind of external clothing to the fibrous roots of the plant.

The plant also produces a fine gum (resin?) as pure as amber, which would, doubtless, be available for many purposes of commerce, although the gums exuding from the palm-trees of New South Wales have hitherto been found too brittle for ordinary use. The seed of the plant is commonly used by the aboriginal natives as food, and may be readily manufactured into the finest starch and farina, the latter property of the plant having been well known and

acted on by the settlers in the district for some time past.

The first attempt to manufacture paper directly from straw and other fibrous substances was made in 1765. There are yet extant a few copies of a treatise published by J. C. Schoffer, Doctor in Theology, at Ratisbonne, 1765, from which the following is an extract :—

"Whereas rags are not to be had in quantity adequate to the wants for the manufacture of paper, I have thought that many plants or barks of trees could be used with advantage to that purpose, and I have tried to obtain the pure fibres from many of them, in which I succeeded entirely, as can be seen by the specimens which are annexed to the end of this volume."

The treatise itself is printed on a white-looking paper made from straw ; but the process was soon given up, as too expensive.

A few years later, the chemist Delisle succeeded in bleaching the bark of the mulberry-tree, but failed as with straw. That kind of bark could not be procured in sufficient quantities, and the process was abandoned. It was not until twenty-five years had elapsed that new trials were made. Seguin obtained a patent in France in 1801 ; Mathias Koop got another in England in 1802 ; and Resbit and Guesticr another shortly after, for the manufacture of straw-pulp. Koop's process was the following :—

"Cut the straw two inches long ; boil it in water in the proportion of two gallons per pound of straw. After it has been drained make it soak in lime-water

during eight days, using two pounds of lime for one of straw, and repeat the operation again and again till the straw is sufficiently softened. If a more agreeable colour is wanted, for every pound of straw use three of crystals of soda after the straw has been washed."

This process, far from furnishing white pulp, did not give as good paper as the straw wrapping-papers of our time. These unsuccessful experiments, made at a time when the war then raging in Europe prevented England from importing rags from the Continent, damped the spirit of invention for nearly twenty years. At length the subject was revived; and in France patents were granted to M. Dessaux, in 1818; to M. Hirogen, in 1820; M. Bronzac, in 1824; and to M. Polar, in 1825. In the meantime a revolution had occurred in paper-making: a machine had been invented, perfected, and generally introduced, producing twenty times more paper than could be made by hand, and with little manual labour. An impulse was thus given to production, and more materials were wanted; and, accordingly, the process of bleaching was improved, and good paper was made of what before was considered as refuse, or, at best, fit only for making pasteboard. But, notwithstanding these improvements, researches after substitutes for rags were never abandoned. From 1825 to 1849 the number of patents granted in Europe for bleaching straw was 137. Every one of the processes described in these patents has completely failed. The last, nevertheless, deserves mentioning. It was granted to Samuel W. Wright, of Massachusetts; the process was mainly mechanical, and good white paper

was the result. A great excitement was created by it; licences were sold in Europe, and machinery was built in England and France, but after a short time it was abandoned, as too expensive.

Mr. A. Mellier, the inventor of a process now coming into use, was connected, as a paper-maker, with the working of S. W. Wright's process in France, and, after its failure, went on experimenting on several of the previous patents, till, finally, he associated himself with Mr. T. Coupier, and, by their united efforts, they discovered the process lately patented in America and in Europe, which is the following :—

"The straw is cut one inch long, and the knots, ears, and grains are separated by winnowing. It is then thrown into a large wooden or iron tub, and a strong boiling solution of caustic soda is poured upon it. This is drawn at the bottom, again warmed by steam, and again poured upon the straw, which operation is repeated till the straw becomes spongy. The straw is then washed; first, with warm water, to take out the soda, and afterwards with cold water, to cool it. It is next taken out and thrown into strong bleaching liquor, where it has to be stirred up every hour, to make the liquor act uniformly. From there the pulp is let down to the drainers in a state called technically half-stuff, and is ready for the beating-engines."

To perform the above simple operations, a good many things are required :—

1. Iron cisterns, for the preparation of caustic soda.

2. Stone cisterns, for preparing bleaching liquor.

3. A reverberatory furnace, to recover two-thirds of the soda.

4. Apparatus to throw uniformly the solution over the straw.

A large steam-boiler, a small steam-engine, and an unlimited supply of water are also absolute requisites.

About forty-eight hours are required to make the straw ready for beating. A quantity of straw, weighing 4,400 pounds, will weigh, after cutting and winnowing, 4,000 pounds, and after bleaching, will produce 2,000 pounds of paper. The fibres of the straw pulp are more uniform than those of rags, and, instead of five hours' beating, require only two hours and a half.

The cost of establishing the special apparatus for making straw-pulp in a mill of ordinary size—say producing two tons of paper in a day—is under £1,000, besides a necessary building. The price of a new mill would be exactly that of a rag-mill, since washing engines and part of the power, &c., necessary for rags, would be dispensed with. The cost of straw-pulp, ready for the beating engine, is warranted by the inventors to be only two-thirds that of rag-pulp of the same quality, and they are ready to treat with manufacturers on that basis.

There is a great difference of opinion among paper-makers about the cost of rag-pulp, and about the proportion lost in working rags (their statements varying between 25 and 47 per cent.) I will not endeavour to prove anything by figures, but will merely give the data respecting straw-pulp. To

bleach 4,400 pounds of straw and obtain 2,000 pounds of paper, there are used:

| | |
|---|---|
| Soda, lbs. .. .. .. .. .. | 400 |
| Lime, barrels .. .. .. .. | 3 |
| Coal, tons .. .. .. .. | 2 |
| Bleaching-powder, lb. .. .. .. | 1,000 |
| Labour, men .. .. .. .. | 12 |

The quantity of soda thrown upon the straw is in reality 1,200 pounds, which, uniting with the gum of the straw, forms a soap, but by evaporation and burning this soap is decomposed, and 800 pounds of soda are recovered, making the loss only 400 pounds.

Coupier and Mellier's process has now been in operation for several years in Ireland, England, and France; the prejudices against it are wearing away. *La Presse* of Paris, the London *Star*, and other journals, are now printed on straw paper. The *Philadelphia Ledger*, the *Dollar Newspaper*, the *New York Tribune*, and various other American journals of large circulation, are printed on straw paper. When paper is made of pure straw-pulp it is too hard, and it has been found better to make it in the proportion of three-fourths of straw and one-fourth of rag-pulp; and thus this hardness is turned to good account. In fact, if it were not for that property of the straw, the thin paper made and used would not sustain itself, but crumple down in the hands of the readers. The proportion of straw in the paper used in the United States varies from 50 to 80 per cent., being on an average 65 per cent.

One of the qualities of straw paper is that it does not easily become greasy.

Paper machines are never built under a certain size, therefore they are made more slowly in mills where there are only a few engines. In such places the production of paper will be doubled by the introduction of the straw process, from the fact that the 75 per cent. of pulp requires no washing at all, and only half the beating of rag-pulp.

The price of rags has been constantly increasing, and an examination of the state of things shows that it will continue to increase.

France, with a population of 36,000,000, turns annually into paper 105,000 tons of rags. Of these, 6,000 tons are imported. In that country the exportation of rags has been prohibited by law since 1850.

Great Britain, with 28,000,000 inhabitants, requires yearly 90,000 tons of rags, about 10,000 of which are imported.

The consumption of paper in the United States is said to be nearly equal to that of England and France combined. There are used in America 6,000 tons of straw for wrapping-paper and pasteboard, and the importation of rags is about to the same extent as in England,—10,000 tons. Formerly the Americans used to get nearly 5,000 tons from Italy, now they scarcely get a third of that quantity, but the deficiency is compensated by supplies from Russia, Chili, Peru, and other new sources.

The above figures clearly show that industrious or rich nations require more paper than they can make with their own rags, and that the deficiency of home supply is made up by purchase from their less advanced neighbours.

But progress is going on very rapidly, and everywhere, as seems to be the case with Italy, the exports will go on diminishing. Rags will sooner or later be insufficient, and other fibrous substances must be used.

Coupier and Mellier's process of bleaching apparatus applies to all fibrous substances, but it has been found less expensive with straw than with barks, woods, gunny-bagging, flax, hemp, marine plants, the refuse of the sugar-cane, &c. In other words, it has been discovered that straw fibre is more easily bleached than other fibre, and as straw is raised everywhere, and the rent and labour are paid for by the grain (there are thirty-five pounds of straw to sixteen pounds of grain), it is found to be the least costly substance, readily available. An American writer, treating on this subject, says: "Some persons have objected that this new employment would make the price of straw rise; but a glance at the statistics will show that were all kinds of paper made in this country entirely from straw, it would not require more than one and a quarter per cent. of the straw crop. But it can never come to that, since rags, cotton waste, &c., being available for no other useful purpose, will have to be sold to paper-makers, whatever be the price." In England, straw will be less extensively available, because it is required for the purposes of the farm, for fodder, &c.

There is very little difference in the value of the various kinds of straw for paper-making. Rye straw is the best, wheat next, and oat straw the least valuable.

At the Exhibition of Metz there were shown specimens of paper manufactured solely of hay by

M. Meyer, of Cusset-in-the-Allier; it sold at seventy-five francs (£3) the one hundred kilogrammes (about 2 cwt.); ninety-eight francs when the paper is composed of equal parts of hay and rags, and one hundred and eight francs when it contains 25 per cent. only of hay.

In the number of Westermann's *Illustrirte Monats hefte für das gesammte Geistige Leben des Gegenwart*, for May, 1861, an article upon "Playing Cards," by Hans Weininger, contains the following facts:—Prideaux says *linen* paper, made from the fibres of the flax plant, is of oriental origin. Mehrs gives 1308 A.D., as that of the oldest document on this kind of paper, and places the date of its manufacture or invention at about 1300. Von Muhr, Breikopf, and Schönemann agree in this. G. Fisher (in Jansen's "Essai sur l'Origine de la Gravure en Bois," &c., Paris, 1808), however, mentions a document on this paper, dated 1301, and states the water-mark to be *Ein Kreis darüber ein Reis, an dessen Ende ein Stern*; that the mark is very plain and distinct, and that the paper is thick and firm in make—hard and well put together. Swandner, Chief Librarian to the Imperial Library at Vienna, gives this paper a much older date, and states that he has found in the Archives of the Cloister of Göss, in Ober-Steinmark, a mandate of the Emperor Frederick II. written on this paper about 1243. The paper is coarse and ragged, in size *seven inches* by *three*.

It is said that a young chemist of Toronto, after having worked for a year in perfecting a process for making white paper from straw, has at last arrived at

the consummation of his wishes. Mr. Clemow—the name of the inventor — has entered into partnership with Mr. Brown; and the discovery has been already patented in Canada and the United States. An agreement has also been entered into between Messrs. Brown and Clemow and the great New York paper-manufacturers, Cyrus Field & Co., which makes the remuneration to be paid the former dependant on paper of certain quality being produced for a certain price, 5 cents. a pound; less than half the present cost. If Messrs. Brown & Clemow succeed in this, then they are entitled to receive 750,000 dollars from the American purchasers of the patent, and will confer an inestimable boon on the world at large.

There are already several patented processes for making white paper both for printing and writing from straw; and this material is largely used in America as well as in Europe for this purpose; but the difficulties in the way of its more general adoption have been hitherto the tediousness of the process, and the great expense in reducing the fibre to pulp, and bleaching it.

If Messrs. Brown and Clemow have really been successful in manufacturing good, cheap paper from straw, they will have benefited the newspaper world to a very great extent, since the cost of the most expensive item in publishing will be reduced very considerably.

The manufacture of paper from straw is one of the many modern examples of the debt due by the arts to the sciences, especially that of chemistry. The researches begun so vigorously by our great country-

man Davy on the chemistry of agriculture, and since so ably followed out by Reugelius, Liebig, and the German schools of chemistry, besides greatly benefiting all classes by an increased produce of the first necessaries of life, have in many more than this solitary instance benefited our manufactures, by pointing out some new use for material hitherto wasted, and so indirectly greatly cheapened the original article. There is, however, yet room for improvement here—room for chemical knowledge to work.

Most of the paper used in Tibet is made from the pulped bark of various species of *Daphne*, and especially of *Edgworthia Gardneri*, and is imported from Nepal and Bhotan; but the Tibetians, as MM. Huc and Gabet correctly state, manufacture a paper from the root of a small shrub; this I have seen, and it is of a much thicker texture and more durable than *Daphne* paper. Dr. Thomson informs me that a species of *Astragalus* is used in Western Tibet for this purpose, the whole shrub, which is dwarf, being reduced to pulp.

A glance at the annexed table of imports will show that we are receiving rags from every part of the world, and to ensure a ready sale on a larger scale, only greater care in preparing them for shipment is necessary. Rags are required to be perfectly dry, sound in staple, as clean as possible, the white and various colours packed separately, and, above all, the cotton and linen entirely free from woollen and mixed woollen, and cotton and other fabrics.

QUANTITIES *of Rags and other Materials for making Paper Imported into the United Kingdom.*

| Countries from whence Imported. | 1860. | 1859. | 1858. | 1857. | 1856. | 1855. | 1854. | 1853. |
|---|---|---|---|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| Russia | 2,238 | 3,253 | 1,668 | 2,115 | 981 | 10 | 45 | 1,071 |
| Prussia | 4,116 | 4,287 | 4,048 | 3,527 | 2,045 | 2,729 | 2,349 | 1,363 |
| Hamburg | 3,020 | 3,325 | 3,073 | 3,528 | 4,690 | 3,310 | 4,348 | 5,084 |
| Bremen | 234 | 320 | 294 | | | | | |
| Tuscany | 924 | 416 | 508 | 1,024 | 745 | 1,331 | 2,002 | 996 |
| Egypt | 2,483 | 1,161 | — | — | 174 | 446 | 282 | — |
| Australia | 530 | 381 | 379 | 144 | 406 | 294 | — | — |
| Sweden | 180 | — | — | | | | | |
| Denmark | 151 | 260 | — | | | | | |
| Holland | 236 | 196 | 135 | | | | | |
| Sardinia | 58 | — | — | | | | | |
| Papal States | 402 | 220 | 397 | 1,858 | 1,243 | 1,294 | 2,389 | 1,173 |
| Naples and Sicily | 220 | — | — | | | | | |
| Austrian Italy | 369 | — | 213 | | | | | |
| British East-Indies | 488 | 238 | 176 | | | | | |
| Other Countries | 474 | 541 | 488 | | | | | |
| Total | 16,123 | 14,598 | 11,379 | 12,196 | 10,284 | 9,414 | 11,415 | 9,687 |

EXPORT *of British and Foreign Rags, and other Materials for making Paper, from the United Kingdom.*

| Countries to which Exported. | 1855. | 1856. | 1857. | 1858. | 1859. | 1860. |
|---|---|---|---|---|---|---|
| BRITISH. | | | | | | |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| France ........ | 13 | 95 | 540 | 18 | 47 | 78 |
| United States .. | 2,118 | 2,900 | 2,521 | 1,185 | 2,074 | 1,340 |
| Belgium ...... | — | — | — | — | — | 249 |
| Other Countries . | 53 | 60 | 20 | 25 | 7 | 129 |
| Total ...... | 2,184 | 3,055 | 3,081 | 1,228 | 2,128 | 1,796 |
| FOREIGN. | | | | | | |
| France ........ | — | — | — | — | — | 1 |
| United States .. | 60 | 97 | 63 | — | 901 | 384 |
| Other Countries . | 7 | 16 | — | 16 | 2 | 1 |
| Total ...... | 67 | 113 | 63 | 16 | 903 | 386 |

QUANTITIES *of Paper made in the United Kingdom, and of the Rags, &c., Imported; and Per-centage of Paper made from Foreign Rags to that made from British Rags.*

| Years. | Quantities of Paper made. | Quantities of Rags, &c., Imported. | Quantities of Paper that Imported Rags would make. | Per-centage of Paper from Imported Rags to total make of Paper. |
|---|---|---|---|---|
| | lb. | lb. | lb. | Per. Cent. |
| 1830 | 62,882,830 | 21,519,680 | 15,063,776 | 24 |
| 1835 | 74,042,650 | 22,182,720 | 15,527,904 | 20 |
| 1840 | 97,237,358 | 20,731,200 | 14,511,840 | 14 |
| 1845 | 124,247,071 | 16,372,160 | 11,460,512 | 9 |
| 1850 | 141,032,474 | 18,197,760 | 12,738,432 | 9 |
| 1855 | 166,776,394 | 21,087,360 | 14,761,152 | 9 |
| 1856 | 187,716,575 | 23,036,160 | 16,125,312 | 9 |
| 1857 | 191,721,620 | 27,319,040 | 19,123,328 | 9 |
| 1858 | 192,847,825 | 25,488,960 | 17,842,272 | 9 |
| 1859 | 217,827,197 | 32,699,520 | 22,889,664 | 10 |
| 1860 | 223,575,285 | 36,115,520 | 25,280,864 | 11 |

Forty years ago, three men, by handiwork, could scarcely manufacture 4,000 small sheets of paper in a day, while now, by use of machinery, they can produce 60,000 in the same time. It has been calculated that if the paper produced yearly by six machines could be put together, the sheet would encircle the world.

The following extracts are from a circular published by Messrs. John L. Bowes & Brother, of Liverpool, at the close of 1861 :—

"7,350 bales of foreign rags have been offered here at auction during the past month, October, and 4,500 bales sold. The repeal of the paper-duty has not yet operated as favourably on the prices of linen and cotton rags as was by some parties anticipated. Speculators bought to a moderate extent during September, and prices improved slightly ; and at an auction held here early in October, when 500 bales were offered, there was a numerous attendance of buyers, and the whole were sold at about 10 per cent. above prices current immediately before. We are receiving rags from every part of the world ; and, to ensure a ready sale on a large scale, only greater care in preparing them for shipment is necessary. Rags are required to be perfectly dry, sound in staple, as clean as possible, the white and various colours packed separately, and, above all, the cotton and linen entirely free from woollen, and mixed woollen, and cotton and silk fabrics. Not less than 1,200 bales of woollen rags were offered on the 7th and 17th October, and 900 sold. For such descriptions as coloured stockings, flannels, blankets, and carpets, suitable for making into grey army blankets, for which

the United States Government has given almost unlimited orders, there has been an excessive demand; and all of this class have been sold at prices showing an advance of 50 to 100 per cent."

An account of the present state of the rag trade at Leghorn is given in the "Annales du Commerce Extérieur." From some changes which have been lately made in the quarantine regulations, that branch of commerce, which has for some time past been in a very depressed state, has now acquired considerable activity. Rags are imported into Leghorn from all the ports of the Mediterranean, the places furnishing most being Greece, Egypt, Tunis, and Algeria. These rags, on reaching Leghorn, are divided into five different categories, and then re-exported. The quantity shipped off amounts, on an average, to from 14,000,000 to 15,000,000 kilogrammes a year: the United States taking about 12,000,000, England 2,000,000, and Spain 700,000 kilos. The prices vary from 21f. 44c. per 100 kilogrammes to 70f. 56c., according to category. France does not import any, in consequence of the high prices.

The following letter, on the collection of rags for the manufacture of paper, was addressed in April, 1861, to the parochial clergy, the managers of parochial institutions, &c., by Mr. Richard Herring, the author of a number of works upon the manufacture of paper:—"The late discussions in Parliament have brought the subject of paper-making and its materials prominently before the public. British machinery and industry produce the finest paper in the world, and

are capable of commanding the market of the world. But paper-making demands a supply of rags, and the Continental duties at present curtail that supply. England requires at least 120,000 tons yearly, of which she supplies but 40,000. The question is, Can that home supply be enlarged? I am confident that it can, and to an extent more than adequate to all its demands. The collection of rags has hitherto been, by a small traffic, in the hands of petty dealers; and the general carelessness of collection and the lowness of price have equally diminished the quantity. It has been ascertained that in scarcely 50 houses out of every 100 any collection is ever made. This negligence arises partly from mistakes as to the nature, value, and manner of the due collection. It has been commonly supposed that white rags alone are of use in paper-making. But coloured rags generally are useful, and even waste paper can be valuably employed in the manufacture. Every housekeeper ought to have three bags—a white one for the white rags, a green one for the coloured, and a black one for the waste paper (the three might be furnished for 1*s.*), which would prevent litter, waste, and the trouble of collecting when the demand came. A suitable agency formed in the towns and villages would settle all demands, arrange the contributions, and reduce the whole into a regular trade. Parochial officers would find attention to this subject a very effectual mode of increasing the means at their disposal for charitable purposes. The general apprehension that we require French or foreign rags for our manufacture is a mistake; we have a sufficient supply at home, if we will

but make use of it. There are more rags wasted, burnt, or left to rot, than would make our paper manufacturers independent of all assistance from abroad. A regular communication ought to be formed by country carriage, and by railroads, for the conveyance of the rags to London, or to those paper-mills in the country which enter largely into the trade. A plan is proposed which will place the whole subject plainly before the public, offer proper pledges, establish proper means, and give the whole movement the degree of activity and regularity which may render it profitable to individuals and the country. The long acquaintance of the writer with the details of the trade enables him to speak with full knowledge of its necessities, its means of success, and its peculiar value to the general interests of commerce. It not less permits him to speak with confidence of the results of relying on our own resources in the present difficulty. We require only the application of the means in our possession. A little industry, a little intelligence, and an established system would perfectly secure us from failure in an important branch of art and trade, already worth £6,000,000 sterling, employing a large number of skilled workmen, and conducing, most effectually, to the industry and comfort of the peasantry, and to the trade and resources of the empire. The present subject is not altogether voluntary; it has been urged on me by letters from various quarters, all expressing the same necessity for making an effort in this direction, for calling the public attention to our resources, and for giving a new impulse to a trade which has hitherto been limited, but which may be carried suc-

cessfully wherever British commerce extends over the globe."

Every one is familar with the pretty, lovely-looking white-flowered Asphodel of our gardens. In the South of Europe, and apparently on both sides of the basin of the Mediterranean, the plant (*Asphodelus ramosus*) is extremely abundant; though it has never, so far as I know, been turned to any account, except that in times of scarcity its acrid fasciculated roots, after much boiling, have been eaten by the poor. In the Paris Exhibition of 1855, there were shown bottles of alcohol extracted from the asphodel; specimens of the residuum of the roots after being twice distilled; paper-stuff from the stalks and leaves of asphodel—card-paper, cards, paper and writing-papers, of various qualities, manufactured from the same, and mixed in various proportions with rags and common paper-stuff. M. de la Bertoche, in a pamphlet, asserts that asphodel roots contain upwards of 27 per cent. of alcoholic principle, or more than double the quantity which resides in the root of beet. The stalks and leaves contain a remarkably tenacious fibre, fine, strong, and flexible. The distillation of asphodel root has been already pursued, and with considerable success, in Algeria; but the immense abundance of the plant in Tuscany, where it has hitherto been considered only a pernicious and most ineradicable weed, points to the advantage of endeavouring to turn it to account. The fasciculated roots, after cleansing and crushing, are mixed with water, and the fluid is exposed to heat, so as to facilitate fermentation. The alchohol which it yields is pure and colourless, per-

fectly transparent, and has the colour of alcohol itself. It contains neither acid, salt, nor oily matter. It burns without leaving any residue, and the flame is remarkably bright. But at the present time, when material for paper seems likely to fail, a most important succedaneum is afforded by the remains of asphodel. It is undeniable that the residuum of the roots after distillation, together with the other parts of the plant, is eminently adapted to this object.

The expense of obtaining the foliage and stalks is no more than that of mowing them. Three processes are necessary: the separation of the useful portions,—the bleaching,—and the reducing the substances into a homogeneous and tenacious pulp. The first is better effected by crushing than by grinding, as the latter mode is apt to destroy the fibre. The second operation involves most difficulty, as the root is covered with a skin which contains a tanning principle; and it is necessary, unless the expensive mode of hand-picking the root be adopted, to expose the substance to air and light, aided by immersion in diluted chlorine, which brings the substance to a very pale brown tint, which is not objectionable for many sorts of paper. For the third process, that of reducing the whole mass to a smooth and tenacious paste, the paper manufacturers must supply the details.

Amongst the multitude of materials which have been proposed for the manufacture of paper, perhaps wood has been suggested the greatest number of times. On more than one occasion the manufacture has been actually carried out, and we saw some years ago really good paper for printing purposes produced

from deal shavings by the patent of J. & C. Watt. It is now said that a French lady has succeeded in manufacturing excellent paper from wood, and at a price much lower than that made from rags. Her method consists chiefly in the use of a new kind of machinery for reducing the wood to fine fibres, which are afterwards treated with the alkalis and acids necessary to reduce them to pulp, and the composition is finally bleached by the action of chlorine. By means of a series of parallel vertical wheels, armed with fine points, which are caused to pass over the surface of the wood in the direction of its fibres, the surface of the wood is marked, and the outer layer is formed into a kind of net, without woof, composed of separate threads. This layer of fine threads is afterwards removed by means of a plane, which is passed across the wood, and the portion thus removed, which resembles lint or flax, is then treated with chlorine, &c. Specimens have thus been made consisting of a mixture of 80 per cent. of wood-pulp, and 20 per cent. of rag-pulp, and sheets have been tried by printers, lithographers, and others, with very satisfactory results. It is the unanimous opinion of the engravers and lithographers who have used it, that paper made according to this method, from wood, and which costs only £16 per ton, is quite equal to the China paper, which costs £214 per ton. It is confidently expected that experiments upon a large scale will confirm the results already obtained.

The most ingenious method of disintegrating the fibre of wood which I have yet heard of is a Yankee "notion." Wood is placed in a cannon, the mouth of

which is plugged up. High-pressure steam is then forced in through the touch-hole, and when the pressure rises to a sufficient degree, the plug, together with the wood, is blown out, the latter being reduced to the appearance of wool by the expansive force of the steam, with which its pores have been filled whilst in the cannon. Experiments conducted by Mr. Robertson, at the Albion Foundry, Hobart Town, to illustrate the practicability of thus exploding bark into fibre by steam power, proved highly successful : the bark, which was inserted in large solid masses into what we may call the steam-digester, being discharged in the shape of a fine fibre.

In some Belgian paper-mills wood is now used as a substitute for rags, to the extent of from 20 to 30 per cent., for printing papers.

A very excellent method of manufacturing paper and pastcboard pulp from wood, originally invented by M. Hartmann, has been improved upon by Mr. Schlesinger, of Bradford, who, after taking much trouble to introduce the plan into this country, is now, as the working partner of the inventor, conducting the process with great success. As the manufacture of paper is a subject at present forcing itself upon public attention, it seems desirable to give prominence to every good improvement relating to it. *Process :*—Cut a tree (say 6 feet long and 2 feet diameter) into nine lengths of 8 inches by 2 feet diameter each ; place these blocks into the boxes, with the fibres running in the same direction as the stone turns ; lever them ; then start the stone at the

rate of about 200 revolutions per minute. By the foregoing process a fibrous pulp is obtained equal to that of ordinary rag-pulp, and lower in price. Moreover, this wood-pulp has the advantage of absorbing a greater quantity of mineral than ordinary rag-pulp, without deteriorating the strength of the pasteboard or paper. Light or hard woods will take the dye of even the most delicate colours as readily as rag-pulp. According to Mr. Schlesinger's calculation, he produces a pound of dry wood-pulp at about one penny, and makes no doubt that, in districts where wood and power can be had cheaper than at Bradford, it may be made at five-eighths to three-fourths of a penny per pound of dry pulp. The cheapest classes of wood, as fir, pine, poplar, willow, &c., suit his purpose best. We have had highly satisfactory specimens of the papers and pasteboards above enumerated submitted to our inspection.

The Hobart Town *Mercury* draws attention to the bark of the "Tea-tree" (the broad-leaved is a *Leptospermum*, and the narrow-leaved a *Melaleuca*), which abounds in the forests of Tasmania, as admirably adapted for the manufacture of paper. Nature itself manufactures paper from it "of her own accord." "During the summer months, when the trees shed their leaves and bark, these accumulate in the gullies and dry creeks. So soon as they are brought into contact with the water they form of themselves a thick pulp, which spreads itself over the uneven surface of the water-courses, and which, after it has been deserted by the water, remains spread out into a huge

sheet of stiff brown paper. The supply is inexhaustible. The rough bark peels off in numerous thin membraneous folds.

A species of *Eucalyptus*, the Stringy-bark tree (*E. obliqua* or *E. fabrorum*), constitutes, in very extensive mountain districts of Victoria, the principal part of the forests. Hence it is not improbable that its bark, which is readily separable, thick, and fibrous, although not tenacious, will not merely continue to supply the roof for the first rustic dwellings of the settlers, but may eventually be drawn into use for the manufacture of a coarse paper, although neither this nor other native products (*Isolepis nodosa*, *Stipa crenata*, *Leptospermeæ*, and *Lavatera plebeia*) are likely to yield a paper comparable to the available maize leaves and stalks in Australia.

The bark of the large-leaved Nettle-tree of Australia (*Urtica gigas*), a tree very plentiful in the cedar brushes upon the banks of the Clarence, in New South Wales, might be utilized. The bark is from $\frac{1}{4}$ to 1 inch thick, and consists of a large proportion of fibre, the interstices of which are filled with a watery juice and soft vegetable matter, both of which are easily removed by crushing or beating the bark until it becomes nearly dry. Steeping in water will not succeed: the whole of the bark rots together. Should this material be found suitable for making ropes, bags, or paper, a large quantity might be procured at from 3*d.* to 4*d.* per pound, provided some cheap and portable machine could be found to prepare it readily.

Two pairs of rollers, worked by a horse, would do

the work effectually: one pair of the rollers to bruise the bark moderately in the first instance, and the second pair sufficiently close to squeeze out the watery and pulpy matter. This, with washing and drying, would partially prepare it; or some scutching or tearing machine, which would separate the fibres, might be found best adapted for the purpose.

In the year 1800, Matthias Koops patented a method of extracting ink from printed and written paper, and re-converting such pulp into writing and printing paper. In the following year he also obtained a patent for manufacturing paper from hay, straw, thistles, waste and refuse of hemp and flax, and different kinds of wood and bark.

In 1824, Alexander Nesbitt, for making paper of "a certain kind of moss which grows in the low watery places of Holland;" and in the same year Louis Lambert, for employing straw freed from knots.

In 1827, the Count de la Garde, for a method of employing the ligneous parts of the stalks of hemp and flax, nettles, hops, or such other textile plants.

In 1832, Peter Young, for making paper from the residue of mangold wurzel, after extracting the juice for the distillation of spirit.

In 1836, Frederick Burt Zineke, from the leaf of the pine-apple plant.

In 1837, Edmund Shaw, for using the envelopes or leaves which cover the ears of Indian corn.

In 1838, Miles Berry, for paper-stuff, from "the *Musa*, plantain or banana, the cannacorous plants, the ficus or fig-tree, the agave or aloe, the Karata plants, the ananas

or pine-apple, the cocoa or cocoa-plant, the palmæ or palm-tree, the macaw-tree or plant; the *Phormium tenax*, or New Zealand flax; the *Saccharum officinarum*, or sugar-cane; and in general all the textile plants which grow between the tropics."—James Vincent Desgrand, for making paper and pasteboard with wood reduced into a state of paste, and of the different sorts of wood that coming under the denomination of white wood—such as poplars—have been found to answer the best.—George Robert D'Harcourt, for making paper from the leaves and stalks of the aloe, the sheaths or covering leaves of the seed or ear of the maize, otherwise Indian corn, the leaves and stalks of the rice-plant; also, the bines or stems of the hop-plant, the common field-bean, the scarlet and French bean, the stalks or stems of the asparagus and potato-plant, and all stalks, leaves, and bines of similar vegetable substances, with or without admixture of rags.—Morton Balmanno, from the bark of trees, and the bark of young shoots of trees; those herbaceous plants which partake of the nature of hemp or flax, having a skin or coating, such as hop-bine, &c.; those plants not having an outward skin or coating, or having it in a very slight degree, but having a fibre intermixed with the ligneous part, such as the stalks of potatoes, &c.; small roots of trees, shrubs, and plants, dead or dried leaves, exclusive of the leaves of maize or Indian corn. —Edward Cooper, from cane trash, or megass.

In 1839, Henry Crosley, from refuse tan and spent hops. — Hewick Zander, from horse-dung, and mixed with straw of any kind, in such a state as the manure is taken from the stables

the pulp being mixed with the pulp of linen rags.—Thomas MacGauran, from hop-bine, either by itself, or mixed with any other suitable material.—Miles Berry, for the application of the class of plants named "Stipa," genus "Gramineæ," and commonly called "Esparto," or *Stipa tenacissima*.

In 1843, Richard Archibald Brooman, for the convolvuli, the cistus genus or family of plants. All the plants of this order may be used; but those known at Guadaloupe as "oua oua," or "baba," which is the "*Mimosa scandens*" of Linnæus, the "*Guilandina bonduc*," "yeux à bourrique," or "yeux à bœuf," and the Ledum, or marsh bindweed, will be found most suitable. The bark of the West Indian pear-tree, and herbes coupantes, of the West Indian islands, are also referred to as applicable.

In 1846, Edmund Nerot, for the bark of the osier and willow.

In 1852, Jean Antoine Farina, for preparing pulp from the plant called "spartum," or "winter broom."—Jean Theodore Coupier and Marie Amedée Charles Mellier, for reducing vegetable matters into pulp by means of a solution of hydrate of soda or potash. The vegetable matters named are straw and barks of some trees, as willow, osier, and chestnut; flax, waste cotton, waste tow of hemp, jute, or sunn, and employing nitric acid in manufacturing pulp from shavings of pine, beech, ash, elm.—George Lloyd, for vegetable fibre, obtained from the fæces or solid excrement of herb-eating animals.—William Edward Newton, for copying-paper, composed of Manila fibre, or the equivalent thereof, such as of the cocoa-nut husk.—Joseph

Alexander Westerman (*provisional protection*), for producing paper and pasteboard from turf.—William Wilkinson, from the awns or beards of barley, rye, and other like grain.

In 1853, Edward Maniere, for applying asbestos in the manufacture of paper. This has lately been again adopted in America. Richard Archibald Brooman, for paper from wood and woody fibres by means of mechanical agents.—Jules Dehau, for employing the fibres of *Stipa tenacissima.*—Joseph Lallemand, for the manufacture of paper from peat.

In 1853, Arthur Warner, for the application of the fibrous parts of the palm-tree and leaf.—Francis Frederick Clossmann, for the application of the fibres of all the species of malvaceous plants, and especially those of *Althea officinalis.*"—Jacques Pierre Henri Vivien, for applying green, yellow, or dead leaves of all kinds of trees and shrubs.

In 1854, James Murdock, for applying a plant called spartum, or water-broom.—Joseph Barling, for improvements in treating hop-bine, and rendering it applicable.—John Lilley, for a new material obtained by crushing the heart or core of the stem of the plantain, banana, and other plants of the same species.—John Jeyes, for pulp from twitch or couch grass; and for employing the refuse of tan-yards.—John Evans, for a new manufacture from the waste refuse of the so-called Brazilian grass, arising from the manufacture of that material into plait or plaited hats.—Thomas Littleton Holt and William Charlton Forster (*prov. pro.*), for making paper with refuse tan and refuse cocoa-nut fibre, and old rope or rags, in equal parts.—James

Acland (*prov. pro.*), for the fibrous portion of the roots of potato, parsnip, turnip; the roots, stems, and stalks of mangold wurzel, chicory, and rhubarb.—Thomas Littleton Holt and William Charlton (*prov. pro.*), for using clover, the hop-stem or bine, and Italian rye-grass, either alone or combined with rags.—Israel Swindells (*prov. pro.*), for digesting wood, such as waste cuttings of timber, loppings of trees, dyers' waste wood or spent wood, underwood, weeds, or vegetable matters in caustic alkali, and producing paper material therefrom.—Alfred Vincent Newton, for an improvement in the process of converting wood into paper.—Samuel Clift (*prov. pro.*), for improvements in making paper from green grass, nettles, and dried grass or hay.—George Thatcher, for the employment of the fibre of the leaves of horseradish.—Edward Gillman, for employing the leaves or fibrous portions of the *Phormium tenax*, or New Zealand flax, the running or creeping plant called giagia, and the species of *Dracæna* called ti, for the production of pulp.—Thomas George Taylor, for the application of the stalk of the hop-plant.—John Coupland, for the preparation of pulp from clover, and grasses of all sorts, from fern, furze, weeds, and rushes, in some cases using a small proportion of flax.—Henry Trappes (*prov. pro.*), for the preparation of leather to be used as a pulp for paper.—George Printy Wheeler and Samuel Bromhead (void), for pulp from the species of plants called "Iris," or the flower-de-luce, or flags, or leaves of flags of every description, known by botanists as a genus of plants of the class Triandria and order Monogynia, which grows in England, throughout

Europe, in the East and West Indies, and many other climates, and are imported into Great Britain in mats, bags, and wrappers, as sugar-mats, &c.—Gurgardin Achille, for the use of the arrow, or water-arrow (*flèche, flèche d'eau,* and *flechière*). The botanical names are *Ranunculus palustris,* according to Tournefort, and *Sagittaria aquatica,* according to Linnæus, of the family of the *Alismaceæ* of Jussieu.—Henry Crossley, for spent tan or spent hops, mixed with fibrous materials, either animal or vegetable.—Samuel Elliott Hoskins, for the fibres obtained from the plant known by the name of *Cyperus longus,* of which the English name is "galingale."—Christopher Hill, for the stems and roots of horseradish, the rush, and the flag, together with the vegetable remains of horse manure.—John Jeyes, for the stems of mustard and other plants of the same class.—William Rossiter and Matthew Edwin Bishop, for pulp from rope shakings, canvas, tow, bagging, and other matters mixed with refuse tan-bark, &c.—Louis Vital Helin, for improvements in the manufacture of paper from straw.—Gustave Hermann Lilie, for the manufacture of paper from the thistle plant.—James Niven, for the application of the hollyhock plant or plants, comprehended under the natural order "Malvaceæ."—Leon Castelain, for pulp from hay, straw, and similar substances.—Henry Diaper, for applying cocoa-nut kernel, after expression of the oil, to the manufacture of paper.—Charles Peterson, for the application of the tree mallow, or *Lavatera arborea.*—Auguste Edouard Loradoux Bellford, for applying down or cotton gathered from thistles, also mosses and lichens.

In 1855, William Johnson, for improvements in the application of various substances containing woody fibre to the manufacture of white paper pulp, as, the inner bass of the lime-trec and other Tiliaceæ, the willow, birch, elder, the leaves of the Coniferæ; also heather and other Ericaceæ, rushes and other Juncaceæ; clover, lucerne, stalks of pease, broom, whin, and other leguminous plants (except the stalks of common leaves), sunflowers, Jerusalem artichokes, and other Compositæ (except thistles), nettles and other urticeæ; turnips, mustard, and other cruciferæ; cucumbers and other cucurbitaceæ; mosses, lycopodium, equisetum, ferns, reeds, canes, bamboos, water lilies, water weeds, *anacharsis aloinastrum*,* and other water plants; rye-grass, pampas-grass, mya, and other grasses; raspberry, blackberry, and other Rosaceæ; malva, sida, and other Malvaceæ (except althea, gossypium, and corchorus); buckwheat, leaves of palms, sugar-cane, Tillandsia, and other Bromeliaceæ; maize and sorghum plant, madder and other Rubiaceæ; anonaceæ, melastomaceæ, velloziæ, panax, solanaceæ, cuphcæ, rhamneæ, lychnophora, terebinthenaceæ, bombax, myrtacea, bignonaceæ, lilaceæ, artocarpeæ, the mulberry, pandanus, cecrops, dracæna, polygaleæ, malpighiaceæ, convolvulaccæ, leaves of musaceæ, broussonetia, bœhmeria, amomum, monispermum, erythroxylon, guttifereæ, ricinus and other Euphorbiaceæ, asclepiadiæ, apocynaccæ, rutaceæ, phormium, iris, solaneæ; the stalk of the tobacco-plant, cactus, papyrus, alocs, agave,

* The botanical description of many of these specifiations is most erroneous and unintelligible.

labiatæ, asparagus, juniper, rice-straw, mandioca plant, gramineæ. For certain pulps, the refuse from breweries, bran, spent tan, and spent dyewoods, and seaweeds may be employed.—John Smith and James Hollingworth, for improvements in treating Surat jute, gunny, or sugar bagging.—Hippolyte Victor Pinondel De la Bertoche, for paper from asphodel root (void).—Francis Parker (*prov. pro.*), for the haulm or stalk of the potato plant.—Richard Archibald Brooman, for preparing the fibres of French beans, scarlet runners, &c. (void).—Alexander Brown, for applying the fern or bracken plant, or plants comprehended under the cryptogamic series.—James Niven, for the common broom plant and the whin plant, *Cytisus scoparius*, and *Ulex Europæa* (void).—John Cowley and Daniel Peyton Sullivan, for improvements in the manufacture of paper from straw.—Jean Pechgris De Frontin, for pulps from the acacia-tree, various kinds of lupins, the plant called *Bryonia*, the stalks of the plant called topinamber or Jerusalem artichoke, and the stalks of the different kinds of *Helianthus* or sunflower.—John Henry Johnson, for employing the waste or residual beetroot.—Lazare Ochs, for the manufacture of certain kinds of paper from the refuse and cuttings of leather during the operation of tanning.—John Louis Jullion, for paper from the fibres of the banana and plantain, from waste or pressed sugar-cane, and the various water flags that abound in warm countries (void).—Francis Burke, for using the plantain, banana, and the aloe.—Giovanni Martenoli de Martinoi and Juan Francisco O. de Lara, for the employment of sea-weed.—Simon Eugene Gabriel Simon, for substituting

in part plants of the family Sparganium for rags.—Joshua Horton and Thomas Horton, for using spent tan.—Robert Martin and John Cowdery Martin, for improvements in obtaining pulp from wood.—William Armand Gilbee, the employment of dog's grass (void).—Francis Moll, for the employment of the stalks and stems of the potato, and the leaves or fibres of the fir-tree, and other conifers. — Theophilus Henry Hastings Kelk, for the use of the bark of elm, of lime, of poplar, of willow, and of marshmallow, canes, or reeds, the leaf-stalk of horseradish and the root of horseradish, the shrubby cane or rod of marshmallow.—Richard Archibald Brooman, for employing the root of the asphodel plant.—John Lilley, for a plant, the growth of West Africa, and known at the Cameroons by the name of Medickey.—Frederic Lotteri, for the bark of trees of the Morus family or class (void).—Charles Mabury Archer, for seaweeds and fresh-water weeds.—Joseph Barling, for the root of the hop-plant (*Humulus lupulus*).—William George Plunkett and John Bower, for *Iris pseudacorus*, commonly called the yellow flagger; the *Arctium bardana*, or woolly-headed burdock ; the *Tussilago farfara*, or common coltsfoot ; the *Beta vulgaris*, red or white beet, or mangold wurzel, and turnip leaves and stems.

In 1856, Claude Louis Parisel, for grass or hay, and similar plants used as forage, and also from weeds and other herbs. — Herman John Van Den Hout and Ebenezer Brown, for making pulp from shavings of leather, mixed with ropes, rags, &c.—Lazarc Ochs, for certain kinds of paper from the refuse of tanned

leather.—Jacob Smith and John Luntley, for treating the sunflower plant (void).—John Cowley, for improvements in the manufacture of paper from straw, &c. (void).—James Niven, from the bark of the elm, *Ulmus Europæus*, and the lecistera formosa.—Herman John Van Den Hout, for curriers' shavings of skins or hides, with a certain per-centage of pulp from rope, &c., or offals and cuttings of all kinds of leather, mixed with textile materials.—William Denny Ruck, and Victor Touche, for using the stem and leaves of sugar-cane, Indian corn, and bulrushes, and the material called bass or bast.—Charles Armand Messager-Abit, for treating the plants ligneum spartium, *Stipa tenacissima, Chamærops humilis,* and the plants of the genera *Genista* and *Stipa.*—John Cowley, improvements in manufacture, from straw, &c.—Thomas Routledge, treatment of Esparto and other raw fibres.—Joshua Horton and Thomas Horton (*prov. pro.*), for using spent tan.—Robert Hanham Collyer, using the residue and substances extracted from the genus *Beta,* that is, beetroot, mangel wurzel, &c.—Adolphe Aubril, application of the residue of the bryony root.

In 1857, Frederick Burnett Houghton, treatment of fibres by heat and pressure.—Lewis Hope, applying the inner bark of the birch and maple.—Louis Jean Marie Siblet, for an improved pulp for paper, by mixing in certain proportions, chloride of lime, alum, carbonated colours, linseed oil, gum copal, acetate of lead, turpentine, essential oil of turpentine, nut oil, cotton, flax, white lead, wheaten flour.—Peter Wicks and Thomas Goulston Ghislin, applying *Juncus serratus, tristus,* &c.; *Aloe arborescens,* &c.; Sanseviera, Malvaceæ, *Watsonia*

*latifolia, narvoso, humilis, papyracea,* &c. ; Tulipa beyniana, &c., plants of South Africa.—Lucius Henry Spooner, paper pulp from *Zostera,* otherwise named wrack grass, or wreck grass.—Robert Hanham Collyer, an improved method of preparing the residue of beetroot, &c.—William Edward Newton, manufacturing paper from wood, or other ligneous or fibrous substances.—Josiah Wright, Alfred Wright, and Francis Roberts, employing the stalk of the rhubarb plant.—William George Plunkett, applying the bark, leaves, and stems of the *Lavatera arborea* (tree mallow), otherwise called arboreum marina nostras ; also the vine or straw of *Humulus lupulus,* or hop-plant, and *Trifolium pratense repens* (common red and white clover).—David Lichtenstadt, making pulp from leather or any kind of animal fibrine, to be used with or without rags.—Joseph Gibbs, a method of treating *Phormium tenax.*—Romain Ignace Charles Dubus, the residue of the bulbs or roots of the lily tribe ; the lily known as the Turk's cap is preferred.

In 1858, Jean Theodore Coupier, for treating straw, cane, reed, dwarf palm, maize stem, jute, &c., for manufacture of paper.—Robert Hanham Collyer, for improvements in making paper from straw.—Jozè Luis, the application of the fibrous textile plant, called in Arabia "Diss," or in Latin "Arundo festuca patula," or by botanists "Festucoides et donax tenax."—Michael Henry, the resulting products of improvements in dyeing and tanning, such as spent tan and dye stuff.—William Edward Newton, improved method of preparing wood pulp.—Philip Davies Margesson, for applying the residue of sugar-cane and

other canes.—Donald M'Crummen, marine plants, and heath, or heather.

In 1859, David Lichtenstadt, for converting bamboo and the like substances into pulp.—Frederick Brown, the leaves or fruit of the "citrus" plant, or tree, generally known as the citron, the orange, and the lemon.—Leon Castelain and Charles Frederick Vasserol, the liquorice root.

Mr. W. G. Plunkett, and J. C. Bower, Esq., C.E., obtained a patent for the manufacture of paper and textile fabrics from the following plants—viz., the yellow iris, or common flagger; the burdock, the coltsfoot, and from the leaves and stems of red and white beet and mangold wurzel; also from the stems of Swedish, Aberdeen, and other turnip bulbs. I have seen specimens of paper and millboard manufactured by hand from several of the foregoing plants, and of fibre from the iris, or yellow flagger, which appears to have all the properties of the best flax. The iris contains a large proportion (at least 75 per cent.) of paper material.

The graceful and useful bamboo is the source of paper supply in China. The paper made from its culm is sufficient to meet the common demands of the Chinese. It is, for the most part, of a quality unfit for European books and newspapers, but in some places the article is manufactured with such care as to answer even for foreign writing-paper. The Anglo-Chinese newspapers, however, find it better to import their material from England. The paper mulberry also contributes to the paper demand in China, and so does rice-straw. Does the reader inquire what becomes of the cast-off or,

rather, fallen-off garments of the uncounted millions of China? The world of letters can derive no aid from Chinese rags until leather becomes more abundant in that country. Crispin claims them all for soles: the shoes of China have soles an inch thick, formed of suitably-prepared paper-rags, fixed with a thin strip of leather.

The leaves of Indian corn (*Zea mays*), have often been experimentalized on, and recommended as a paper material, but have not yet come into general use. The supply of this waste substance might be very large. The chief use of the leaves, &c., hitherto, has been for packing purposes, stuffing mattresses, and wrapping oranges. When we consider the enormous crops of maize in North America alone, the material, if husbanded, might become profitable. Recent experiments have proved it to possess, not only all the ordinary qualities necessary to make good paper, but to be in many respects actually superior to rags. Indian corn, it is true, cannot be grown except in countries with a certain degree of temperature—at least, not with the prolific result of warmer climates; yet the plant is of frequent occurrence all over the continent of Europe, and can be easily cultivated to a degree more than sufficient to satisfy the utmost demands of the paper market. Besides, as rags are likely to fall in price before long, owing to the extensive supply of material resulting from this new element, the world of writers and readers would seem to have a brighter future before it than the boldest fancy would have imagined a very short time ago. This is not the first time that paper has been manufactured from the blade

of Indian corn; but, strange to say, the art was lost and required to be discovered anew. As early as the seventeenth century, an Indian-corn paper-manufactory was in full operation at the town of Rievi, in Italy, and enjoyed a world-wide reputation at the time; but with the death of its proprietor the secret seems to have lapsed into oblivion. The manifold attempts subsequently made to continue the manufacture were always baffled by the difficulty of removing the silicious, resinous, and glutinous matters contained in the blade.

The recovery of this process has at last been effected, and is due to the research of one Herr Moritz Diamant, a Jewish writing-master in Austria. Having busied himself for some time in experiments on Indian corn, the ingenious discoverer has at length been rewarded with the desired results of his labour; and a trial of his method on a grand scale, which was made at the Imperial manufactory of Schlögelmühle, near Glegnitz (Lower Austria), has completely demonstrated the certainty of the invention. Although the machinery, arranged as it was for the manufacture of rag paper, could not, of course, fully answer the requirements of Herr Diamant, the results of the essay were extremely favourable. The article produced was of a purity of texture and whiteness of colour that left nothing to be desired; and this is all the more valuable from the difficulty usually experienced in the removal of impurities from the rags. Knots, and other inequalities of surface, so frequent in the ordinary paper, and which give so much trouble in printing, the new product is entirely free from, and this without the

material undergoing any special process to attain the desired end.

Another great advantage, and this in an economical point of view, is the reduction of the steam power required in the manufacture by *one third* of its present amount, in consequence of the material being reduced to pulp by chemical, and not, as at present, mechanical agency. The present proprietor of the invention is Count Carl Octavio Lippe, of Wessenfeld, who has bought it from the originator, and from several experiments deduced the following results :—

1. It is not only possible to produce every variety of paper from the blades of Indian corn, but the product is equal, and in some cases even superior, to the article manufactured from rags.

2. The paper requires but very little size to render it fit for writing purposes, as the pulp naturally contains a large proportion of that necessary ingredient, which can at the same time be easily eliminated if desirable.

3. The bleaching is effected by a very rapid and facile process, and indeed, for the common light-coloured packing-paper, the process becomes entirely unnecessary.

4. The Indian-corn paper possesses greater strength and tenacity than rag paper, without the drawback of brittleness, so conspicuous in the common straw products.

5. No machinery being required in the manufacture of this paper for the purpose of tearing up the raw material and reducing it to pulp, the expense, both in

point of power and time, is far less than is necessary for the production of rag paper.

Count Lippe having put himself in communication with the Austrian Government, an imperial manufactory for Indian-corn paper (*mais-halm papier*, as the inventor calls it) is now in course of construction at Pesth, the capital of the greatest Indian-corn-growing country in Europe. Another manufactory is already in full operation in Switzerland; and preparations are being made on the coast of the Mediterranean for the production and exportation, on a large scale, of the pulp of this new material.

It is not merely the blades of Indian corn, but the leaves, the tassel, the sheathing of the grain, the cob, and the stalk might all, I believe, be utilized by the paper-manufacturer. A reference to the list of paper materials patented, already given, shows that this substance has often been taken into consideration, but never as yet been obtained in quantity, or manipulated upon satisfactorily. Let us hope that a great traffic will arise in this cheap and useful material, and that English vessels will, before long, be freighted with ship-loads of books and papers *in futuro*. In Brandenburg, with its indifferent soil, and where the temperature is certainly not higher on the average than that of Great Britain, Indian corn, though a novel introduction, may now be seen on many a sandy acre rearing up its broad leaf-blades to a height of half a dozen feet or upwards.

Another wild plant which has lately come into general use for paper manufacture is one known as Alfa (*Stipa tenacissima*), Esparto, Sparto, or Spar-

tum. Several species of this grass grow wild on both shores of the Mediterranean for about five degrees of longitude, and are particularly abundant in some of the seaboard provinces of Algeria. They are found upon arid, rocky soils, having bases of silica and iron. In Spain the herbaceous stalks of esparto have been used a textile for centuries, for ropes, mats, sandals, baskets, &c. ; also in the manufacture of a coarse paper. *Lygeum spartum*, *Stipa gigantea*, *S. barbata*, and other species, are also employed.

The attention of the French Government has for years past been directed to this plant as a substitute for rags; and in the London Exhibition of 1851, samples of alfa, as well as paper made from it, were shown in the Algerian section of French products. In consequence, however, of the difficulty of transport, and the imperfect methods then employed in its preparation, little progress was made; but the recent legislative enactments in England respecting paper, and the increasing prices of rags abroad, have caused the manufacturers here to pay more attention to this plant, and experience has proved not only its superiority to straw, but its perfect adaptability to making paper, either by itself, or when mixed with straw or rags.

The efforts which have been made to utilize more generally the herbaceous stalks of this grass have been attended with the most beneficial results, and for paper pulp it has been found exceedingly valuable producing paper of great strength and tenacity. A large paper-mill has been established at Arba, near Algiers, and the *Akhbar* daily paper, one of the oldest

journals of Algeria, is now printed on paper of African origin, made of the fibres of alfa, diss (*Arundo festucoides*), and of the dwarf palm (*Chamærops humilis*), all wild plants, met with in abundance.

The prosecution of an export trade in these fibres was long retarded by the stringent customs regulations of France.

M. Michel Chevalier, some years ago, pointed out that the man of business-enterprise and capital in Algeria was placed in the same tantalizing situation as Sancho Panza in the island of Barataria: in the presence of a table covered with dainty viands, he was continually arrested by the command of the doctor, who prohibited his touching the various delicacies which tempted his appetite.

"The plains of Algeria," wrote M. Chevalier, "offer, without culture, a plant excellently adapted for making paper of the first quality: this is alfa, or esparto. The importation into France is permitted in the rough state—that is, with the stalks or stems tied up in bundles, like forage. From their excessive bulk, it is scarcely possible to transport them profitably any great distance, or to ship them; but when, by maceration, it is made into a pulp, and greatly diminished in weight and bulk, so as to be conveniently transportable, it is prohibited in France. The time is coming, however, when France will be open without duties to all Algerian productions."

Recent measures, taken by the Minister for Algeria, have greatly modified the customs regulations for French colonies. All its natural products, and a great

many of its industrial and manufactured products, are now freely admitted.

The alfa, in its wild state, grows in a tuft or clump, of which only such stalks as have come to maturity and are full of sap ought to be gathered. If gathered too green, it produces a transparent fibre, with immense waste; if, on the other hand, too ripe, the constituent elements of silica and iron are with difficulty removed. The proper months for the harvest in Africa are, therefore, April to June. It must be gathered by hand, and left to dry for a week or ten days, before being removed for packing. From the green to the dry state it loses 40 per cent. of its weight; but even in this latter condition it is so cumbersome that when shipped in loose bundles, one ton weight occupies from four to five tons space. When placed under a hydraulic press, however, it can be packed into bales, with iron hoops, which reduce it to half the above volume, as far as space is concerned, each bale averaging about $2\frac{1}{2}$ cwt., and 10 bales weighing $1\frac{1}{4}$ ton. When thus compressed, the alfa fibre can be transported not only with greater facility, but this method of packing (resembling, in fact, bales of pressed hay) keeps the fibre clean, and renders it of easy stowage.

In the above manner, considerable exports have lately taken place to France and Belgium, where its use is every day increasing; and it is now introduced upon the English market in the same form, with the conviction that the superior advantages of packing, as well as condition and quality, will not fail to attract

the notice of paper-manufacturers. The method of treatment for paper is now so well known that any detailed statement is unnecessary.

The chemical constituents of the plant are as follows :—

| | | |
|---|---|---|
| Yellow colouring matter .. | 12·0 | 26·5 |
| Red " " .. .. | 6·0 | |
| Gum and resin .. .. .. | 7·0 | |
| Salts, forming the ashes of the Alfa | 1·5 | |
| Paper fibre .. .. .. .. .. | | 73·5 |
| | | 100·0 |

M. de Paravey, in a recent communication to the Academy of Sciences, Paris, called the attention of the members to a plant from which an excellent kind of paper is made in Upper Scinde and to the north of the Himalaya mountains. This paper is much used in Thibet, and amongst the native bankers of India ; and its employment is referred to by Moorcroft and other travellers. When it has become soiled and written upon, it can be made up again and rebleached. The plant in question is the *Ruscus aculeatus*, commonly known in this country as butcher's broom, which is met with in considerable quantity in most woody districts.

A paper read by Chevalier Claussen, at one of the meetings of the British Association for the Advancement of Science, on plants which can furnish fibre for paper pulp, contained some interesting information.

"The paper-makers are in want of a material to replace rags in the manufacture of paper, and I have, therefore, turned my attention to this subject. To

make this matter more comprehensible, I will explain what the paper-makers want. They require a cheap material with a strong fibre, easily bleached, and of which an unlimited supply may be obtained. I will now enumerate a few of the different substances which I have examined, for the purpose of discovering a paper-substitute for rags, containing about 50 per cent. of vegetable fibre mixed with wool or silk, which are regarded by the paper-makers as useless to them, and several thousand tons are yearly burned in the manufacture of prussiate of potash. By a simple process, which consists in boiling these rags in caustic alkali, the animal fibre is dissolved, and the vegetable fibre is available for the manufacture of white-paper pulp. Jute, the inner bark of *Corchorus Indicus*, produces a paper pulp of inferior quality, bleached with difficulty. Agave, *Phormium tenax*, and banana or plantain fibre (Manila hemp), are not only expensive, but it is nearly impossible to bleach them. The banana-leaves contain 40 per cent. of fibre. Flax would be suitable to replace rags in paper-manufacture, but the high price and scarcity of it, caused partly by the injudicious way in which it is cultivated, prevent that. Six tons of flax straw are required to produce one ton of flax fibre, and by the present mode of treatment all the woody part is lost. By my process the bulk of the flax straw is lessened by partial cleaning before retting, whereby about 50 to 60 per cent. of shoves (a most valuable cattle-food) are saved, and the cost of the fibre reduced. By the foregoing it will be seen that the flax plant only produces from 12 to 15 per cent. of paper pulp. All that I have said about flax

is applicable to hemp, which produces 25 per cent. of pulp. Nettles produce 5 per cent. of a very beautiful and easily-bleached fibre. Palm-leaves contain 30 to 40 per cent. fibre, but are not easily bleached. The *Bromeliaceæ* contain from 25 to 40 per cent. fibre. *Bonapartea juncea* contains 35 per cent. of the most beautiful vegetable fibre known: it could not only be used for paper pulp, but for all kinds of manufactures in which flax, cotton, silk, or wool is employed. It appears that this plant exists in large quantities in Australia, and it is most desirable that some of our large manufacturers should import a quantity of it. The plant wants no other preparation than cutting, drying, and compressing like hay. The bleaching and finishing may be done here. Ferns give 20 to 25 per cent. fibre, not easily bleached. *Equisetum* from 15 to 20 per cent. of inferior fibre, easily bleached. The inner bark of the lime-tree (*Tilia*) gives a fibre easily bleached but not very strong. *Althæa* and many *Malvaceæ* produce from 15 to 20 per cent. paper pulp. Stalks of beans, peas, hops, buckwheat, potatoes, heather, broom, and many other plants, contain from 10 to 20 per cent. of fibre, but their extraction and bleaching present difficulties which will, probably, prevent their use. The straws of the cereals cannot be converted into white-paper pulp after they have ripened the grain: the joints or knots in the stalks are then so hardened that they will resist all bleaching agents. To produce paper pulp from them they must be cut green before the grain appears, and this would probably not be advantageous. Many grasses contain from 30 to 50 per cent. of fibre, not

very strong, but easily bleached. Of indigenous grasses the rye-grass contains 35 per cent. of paper pulp; *Phalaris*, *Dactylis*, and *Carex*, 30 per cent. Several reeds and canes contain from 30 to 50 per cent. of fibre, easily bleached. The stalk of the sugar-cane gives 40 per cent. of white pulp. The wood of the *Coniferæ* gives a fibre suitable for paper pulp. I made this discovery accidentally, in 1851, when I was making flax-cotton in my model establishment at Stepney, near London. I remarked that the pine-wood vats in which I bleached were rapidly decomposed on the surface into a kind of paper pulp. I collected some of it, and exhibited it in the Great Exhibition; but as, at that time, there was no want of paper material, no attention was paid to it. The leaves and top branches of Scotch fir produce 25 per cent. of paper pulp. The shavings and sawdust of wood from Scotch fir give 40 per cent. pulp. The cost of reducing to pulp and bleaching pine-wood will be about three times that of bleaching rags. As none of the above-named substances or plants would entirely satisfy on all points the wants of the paper-makers, I continued my researches, and at last remembered the *Papyrus* (the plant of which the ancients made their paper), which I examined, and found to contain 40 per cent. of strong fibre, excellent for paper and very easily bleached. The only point which was not entirely satisfactory was relative to the abundant supply of it, as this plant is only found in Egypt. I directed, therefore, my attention to plants growing in this country; and I found, to my great satisfaction, that the common rushes (*Juncus effusus* and others) contain 40 per cent. of

fibre, quite equal, if not superior, to the papyrus fibre, and a perfect substitute for rags in the manufacture of paper, and that one ton of rushes contains more fibre than two tons of flax-straw."

Colonel Jenkins, in a communication made to the Agri-Horticultural Society of India, observes :—" We have no end of allied plants in the families *Cyperaceæ* and *Juncaceæ*, and if it were found practicable in this country to reduce the plants to a pulp, we might be able to import it in large quantities in a dried and packed state ; or the plants might be dried only, and then be pressed into bales to be reduced to pulp at home by machinery. Of nearly all the *Cyperuses*, mats are made by the natives, and some of them are beautifully white, and there seems but little doubt we might send them home in the state as prepared for being woven into mats with no small profit, if found to be well adapted for making paper. Mats are also made of various Juncuses, and they are so similar that I have no doubt they can be equally used. I think it also likely that our common *Phrynium dichotomum* (Calcutta mats) might be found serviceable, and other plants of the families of *Marantaceæ* and *Zingiberaceæ* : the *Alpinias*, for instance, and *Costuses*, of which plants there are no end throughout the eastern districts. In Herring's work on Paper and paper machinery there is a brief mention of the mode in which pulp is manufactured from the bamboo by the Chinese, p. 31 ; but though the bamboo paper may be useful for many purposes, the cheapest article and the best will be found amongst the grasses. If wheat straw affords a good pulp for paper, I should think

rice straw would give a better, for it is apparently a much tougher substance."

Another waste product which has been attempted to be more extensively utilized is that pest to agriculturists, the Thistle. A number of persons, it is stated, have been lately employed in the neighbourhood of Sens (Yonne) in collecting thistle-heads for a paper-manufacturer, who uses them as a substitute for rags. There is abundance of this raw material to be obtained at a cheap rate in many countries. An Australian paper observes :—" It is so customary to think and speak of the thistle only as a nuisance to be extirpated, that the settler is slow to believe this much-despised plant can be of any value. It is a fact, however, worth noting, that horses and cattle are exceedingly fond of the thistle. It is true they will not crop it as it grows from the ground; but this is simply because the sharp spines or prickles with which the plant is studded injure the animal's lips and mouth, and prevent him from chewing it. But let the thistles be cut down or rooted up, and allowed to lie exposed for a day or two; the spines will then droop and become quite soft, and in this state horses or cattle will prefer the thistle to almost any kind of green food. Within these few days past, we have seen horses rejecting rich grass-feed indulge themselves on thistles which had been rooted up a few days before and had become soft, and there was no mistaking the relish with which the animals were feeding. A gentleman in this neighbourhood, who had noticed the fondness of the horse for the thistle in this state, and observed the fattening qualities of the plant, is accus-

tomed to leave a quantity growing in his paddock, which he cuts when young for use. Both horses and cattle, with an exercise of instinct which almost amounts to reasoning, have been known to trample on the thistle when growing in the ground, for the purpose of crushing the spines, after which they will eagerly eat the plant. It may be observed that the thistle which abounds in these districts is of the variety known as the Pampas thistle, and was originally introduced from South America, the seeds having been probably conveyed entangled in the manes of imported horses. The plant is of a very succulent nature; and, since it seems almost impossible to extirpate it, it would be good policy, at all events, to turn it to some useful account, as may easily be done by any one who will be at the trouble to try the experiment."—*Goulburn Chronicle.*

In Head's "Rough Notes of Journeys across the Pampas," he states that he passed through a region covered for 180 miles with clover and thistles. In winter the leaves of the thistles are large and luxuriant, and the whole surface of the country has the rough appearance of a turnip-field. In spring, the clover has vanished, the leaves of the thistles have extended along the ground, and the country still looks like a rough crop of turnips. In less than a month the change is most extraordinary: the whole region becomes a luxuriant wood of enormous thistles, which have suddenly shot up to a height of ten or eleven feet, and are all in full bloom. The road or path is hemmed in on both sides; the view is completely obstructed; not an animal is to be seen; and the

stems of the thistles are so close to each other, and so strong, that, independent of the prickles with which they are armed, they form an impenetrable barrier. The sudden growth of these plants is quite astonishing; and though it would be an unusual misfortune in military history, yet it is really possible that an invading army, unacquainted with the country, might be imprisoned by these thistles before they had time to escape from them. The summer is not over before the scene undergoes another rapid change: the thistles suddenly lose their sap and verdure, their heads droop, the leaves shrink and fade, the stems become black and dead, and they remain rattling with the breeze one against another, until the violence of the pampero, or hurricane, levels them with the ground.

In the Russian steppes the wormwoods and thistles grow to a size unknown in the rest of Europe; it is said that the thistle-bush found where these abound is tall enough to hide a Cossack horseman. The natives call all these rank weeds, useless for pasture, *burian*, and, together with the dry dung of the flocks, this constitutes all the fuel they possess.

According to a patent taken out in July, 1854, by Lord Berriedale, all varieties of the thistle are applicable for paper-making, but more particularly the large Scottish thistle, which grows much too luxuriantly in many parts of Great Britain, attaining a great height and thickness of stem, and which furnish in each plant fibre of great tenacity to a large amount. This, when duly prepared, is stated to be well suited for the preparation of a paper pulp, which will cohere very powerfully, as well as prove useful in textile manu-

factures. It may be used either green or dry; if for paper, it goes through a process similar to that which rags are subject to, and if for manufactures, like flax.

The common stinging nettle has a splendid fibre, and in Germany has been made into first-class paper. The world is so prosperous, so well to do and well dressed, that commerce cries in vain for rags to feed the paper-mills. And here are millions of reams of the green material—the much-abused and long neglected nettle—idly growing in our very ditches. And now this thing of ditches shall be gathered and steeped, and daintily manipulated, and come forth to the world in its revealed self, the whitest, purest paper! Beauty that would squeal at a touch of the saw-edged leaf of the nettle, calling it a cruel odious thing, may now lay her hand on the purified leaf, and, tracing thereon gentlest thoughts for eager, happy eyes, may bless the common stinging nettle.

It has been proved, then, that paper can be made of almost anything,—from the bark of trees, the down of the Asclepiads, whose rankness is one of the greatest nuisances the gardener has to contend with,—silk, flax, or cotton waste,—sea-weed, the tendrils of the vine, beetroot refuse, cabbage stalks, potatoes, wood-shavings and sawdust,—ferns, grasses, nettles, and peat, a substance covering hundreds of thousands of square miles in Ireland and other parts of Europe. I have seen samples of beautiful drab-coloured paper made in Western Canada from scraps of leather, straw, and rags.

There are thousands of fibrous materials in the world of nature that the art of man can macerate into

pulp, and shape into paper. The very wasps with their weak mandibles construct their paper nests as a lesson for him, while ocean and river, by their action on vegetable substances, show him the adaptability of certain plants to felt and cohere into paper material. A hundred substances are ready for trial round any one's country residence, some of which would succeed. Much of the great pressure might be relieved as to material, if coarse and coloured papers were more generally used. In America many substances are used that paper-makers in England do not dream of; such as marsh-hay, oat and barley straw, cane-brake, Indian-corn stalks, and woollen refuse. These are mixed up with a little strong fibre, and every pound of such substances releases a pound of material fit to purify and bleach for fine papers.

Varieties of fibres adapted to replace rags in the manufacture of paper could be had in great abundance in Trinidad. The coarser qualities are obtainable in enormous quantities from the palms and other indigenous plants. A systematical botanical examination of the colony would allow its natural products to be favourably contrasted in quality and quantity with those of a similar nature from the Baltic, with whose shores communication, at all times uncertain, is occasionally liable to interruption from natural or political causes.

The uses of paper in Japan are innumerable, of which the large collection sent home by the Japanese government, through Mr. Rutherford Alcock, to the International Exhibition of 1862, affords a striking example.

The Japanese paper handkerchiefs will be coming into use here soon; at least, paper neck-kerchiefs, scarfs, or neck-ties, "in almost every colour and pattern," are among the latest of those inventions for which Mr. Gladstone and his removal of the tax on paper must be held responsible. It is not paper neck-ties alone, however, that are now advertised as the latest novelty in the paper-drapery line, but "paper bands for clergymen and members of the bar,"—especially those "members of the bar," we dare say, who have plenty of room in their empty brief-bags for a stock of paper-drapery. There are also "paper shirt-fronts," "paper waistcoats," "paper hats, waterproof," and "paper bonnets of the latest fashion, trimmed with paper lace and paper flowers;" besides "paper lace" and "paper lace collars, cuffs, and stomachers for ladies," and various other forms of paper-drapery, millinery, and mantua-making. Of the paper neck-ties the *Critic* says:—"They are printed in imitation of silk and gingham, with such exactness as to defy detection, save on close inspection!" The same paper states that, at a recent meeting of the paper-manufacturers, "some extraordinary samples of newly-imported Japanese paper were exhibited, one of which was of such prodigious strength that the material of which it is composed might be manufactured into ropes; and another, which is fit for bed-hangings and wearing apparel, so much resembles stuffs of wool and silk that it is often taken for them." Thus, like so many others of our Western novelties, we see that paper-drapery, or linen shoddy, is an Eastern invention, and probably

not a new one at all. There seems to be a prospect, too, of a return to the papyrus of ancient Egypt, as one of the very best materials for the anticipated great extension of the paper-manufacture.

Waste paper is now very generally collected to be worked up again, especially envelopes, old letters, &c. The Military Finance Department at Calcutta recently issued an order to the offices subordinate to it about the sale of waste paper. It seems that all the rubbish in the shape of torn envelopes of letters received, &c. &c., is to be collected carefully every evening, and stowed away in some secure place. This is to be done daily until the close of the month, when the month's accumulation is to be brought out and sold to the *Bickree wallas*, the proceeds of such sale being credited to the Government.

The waste paper of the Government offices, which is collected and sold by H. M. Stationery Office, produces about £7,000 a year. This is independent of the "blue books," printed, but not read, which, after the lapse of a certain time, are disposed of as waste paper by Mr. Hansard. Many members of Parliament from time to time make a clearance of the files of Parliamentary papers which accumulate on their shelves, which are handed over at waste paper price to booksellers and dealers. A new application of waste paper has recently come into use; namely, the re-working up of newspaper sheets, either remaining on hand, or bought up in quantity for the purpose. These serve to print broadsides and posters; the large prominent black letters obliterating or obscuring the smaller newspaper type.

In the offices of bookbinders and paper-makers, the clippings and shavings from the plough-knife, shears, &c., are sold either for re-working or filling fire-grates in summer, &c. They are sometimes used for filling pillows and cushions. The amount realized for the clippings in many paper warehouses reaches a large sum annually. There are many waste dealers in the metropolis who clear out wholesale the paper from news-rooms, merchants' counting-houses, public offices, &c., and retail it to cheesemongers, butchers, and others.

---

## MISCELLANEOUS APPLICATIONS OF WASTE SUBSTANCES.

Brewers' grains, the spent malt of the brewery, are bought for feeding milch-cows and swine.

Malt commings, the acrospire or shoot of the barley after being kiln-dried, has been used as a coffee substitute, as well as by farmers for manure.

We do not cook our peas in the pod, or eat the pods, as they do in France, although they are supplied largely to milch-cows in the metropolis during the season; and van-loads of the pods may be seen carted away from Covent Garden to the different dairy establishments. Several hundred females are employed shelling peas in the neighbourhood of the market. The pea-shells have been recommended as a paper material, and they have been used for distilling from in France.

A by-product from the manufacture of mustard, is a manure-cake made from the husks or bran of the seed. The process of manufacture is interesting and

somewhat ludicrous. Several long stocking-like bags are filled with the bran at the factory, and then piled one above another in a hydraulic press. The pump is worked, and the well-filled stockings are gradually squeezed flat, while little streams of bland dark oil trickle down the press into a reservoir below. The action of the press is now reversed, and the cakes are lifted out one at a time, and handed by the press-man to his attendant. The latter, on receiving one of these flattened limbs, rests it on a support and pulls off the stocking. The leg thus exposed to view is about the size and nearly the shape of a tailor's sleeve-board. Having likened the cake to a leg, the looker-on feels rather uncomfortable when the workman pares the edges with a knife ; but the appearance of the mangled limb is much improved by the operation. The cake is now ready for the market, and will fetch a good price, as it forms a valuable manure, particularly for land infested with the wire-worm.

The mixture of fibre and gluten left in the separators or tanks, in the process of starch-making from rice, is sold at a good price for feeding pigs. As, however, the pig-keepers in the vicinity of large works cannot use up the whole of the product, a set of hydraulic presses are constantly at work squeezing this nutritious material into compact cakes, which can be packed in a comparatively small compass, and transmitted to the hungry pigs of remote parts.

Under the name of leef or louff, the interior netted fibres of the towel-gourd (*Luffa Ægyptica*) are used in Turkish baths as a sponge or flesh-scrubber. Little baskets and various fancy articles are frequently

made of this substance in the colonies and on the Continent, and many specimens were shown at the International Exhibition.

The rough leaves of the chaparro (*Curatella Americana*, Linn.) are very generally used in Trinidad for smoothing fine woodwork, and are preferred for a finish to sand-paper.

Razor-strops made from the corkwood (*Ochroma Lagopus*), from the langue-bœuf (*Agave vivipara*), from *Pterocarpus draco*, and from *Anona palustris*, were shown in 1862 from Trinidad and from Dominica.

The ashes of the cauto-bark (*Hirtella silicea*, or *Moquilea sp.*) are used to mix with clay to make the Indian pottery in Trinidad.

The leaves of the potato-plant when roasted may be advantageously employed for thickening mordants in dyeing. The leaves have lately met with a ready sale to the dyers of Mulhouse, at 35 francs the 50 kilogrammes.

Mr. Septimus Piesse, the perfumer, in a letter to the "Journal of the Society of Arts," subsequent to one of my papers read before the members, observes :—

"With reference to the subject of Mr. Simmonds's paper, I have seen with regret that the gardeners and horticulturists waste their flowers, which by a proper application of known principles could be economized. Flowering plants are cultivated, but they do not always find a market. Now it is a real waste not to utilize the blossoms which

'Waste their fragrance in the desert air.'

"It is not in England alone that this occurs, but in

her colonies. In Jamaica, in St. Helena, and many other places, orange-blossoms and jasmine-flowers are very abundant, but no effort is made to save or economize their fragrance, although the ottos procurable from them are nearly as valuable as gold, weight for weight, and for these England pays pretty dearly to France and Italy. There is a steady and regularly increasing demand for the odorous principle of flowers by the perfumery factors of England. Why, then, do not some of the British colonies supply this demand?"

How much also remains to be done in the production of wines, brandy, cider, vinegar, shrub, cordials, essences, and liqueurs of all kinds from tropical juices and fruits. Aromatic wines, with lasting bouquets, might be made in abundance. Look at the fruits with their luscious flavour, which are so much wasted; the pommerose, the pineapple, the guava, the mango, mammy-apple, limes, and oranges; whilst granadilla flowers, orange flowers, and the vanilla, arc at hand for giving perfume. Peach brandy is largely manufactured in the United States.

In twenty-four hours vinegar may be made from numerous tropical juices in abundance.

The production of alcohol might be greatly extended, if necessary. Rice, jaggery, and the palm juice, or toddy, in India, could be extensively applied to the production of spirit, which is so much in request for various tinctures, preserves, spirit-lamps, ether, in the chemical and pharmaceutical laboratories, for dissolving gums and resins, preserving objects of natural history, and other purposes.

An exeellent eider beverage may be obtained from the juice of the pineapple by fermentation. Old Ligon, the early historian of Barbados, writing two eenturies ago, speaks in raptures of it :—"The last and best sort of drink that this island or the world affords, is [says he] the ineomparable wine of pines ; and is certainly the nectar which the gods drinke, for on earth there is none like it ; and that is made of the pine juyee of the fruite itself, without commixture of water or any other creature, having in itself a natural eompound of all tastes excellent that the world can yield. The drink [he adds] is too pure to keep long ; in three or four days it will be fine ; 'tis made by pressing the fruit and strayning the liquor, and it is kept in bottles."

In Mexico, a most nourishing and refreshing beverage, known as *tepache*, is compounded of pineapple juice, parched corn, and sugar.

How little attention has been paid to the trade in succades, jams and jellies, which by their lusciousness, purity, whiteness, and clearness, might surpass anything produced in Europe, and could be sent from our colonies in large quantities at a very cheap rate. A new era ought to be opencd up in eonfectionery from the West Indies—an art which seems to have been intended in particular for islands produeing in luxurious abundance sugar, and all the rieh and palatable fruits susceptible of preparation. Bordeaux, Marseilles, Spain, and Greece have, be it remembered, established an immense trade for their dried fruits, and with sugar obtained at seeond-hand. The manner in whieh a large trade in fruit ean pro-

fitably be carried on is shown in the commerce in oranges from the Azores and Portugal, in grapes, melons, peaches, and other delicate fruit from the Continent, and in pineapples from the Bahamas and the coast of Africa. Dried fruits of various kinds might be experimentally tried from the colonies, and the Society of Arts has repeatedly endeavoured to stimulate colonists to experiments in this line.

How rich also are many localities in *medicinal plants*, the useful properties of which are well known to the natives. Central and South America particularly abound in these, and Mr. Berthold Seeman, in his Flora of Panama, has recently given a long list of new ones worth trial by our pharmaceutists, which are recommended as febrifuges, purgatives, tonics, emetics, vulneraries, anti-syphilitics, antidotes, &c. The soil of tropical countries is almost overrun with those plants famous for different virtues. A correspondent in Ceylon writes me :—"I have lately been using the snake gourd (*Trichosanthes palmata* and *T. cucumerina*), with much success as a febrifuge. I shall be glad to send you some of this herb, together with my notes and remarks on it. I have just begun to subject the indigenous plants of this island to direct chemical experiment, with a view to ascertain their therapeutic effects."

Among the foreign products at the International Exhibition of 1862 we find extensive collections of medicinal wild plants, &c., from Japan, China, India, and South America, of the properties of which scarcely anything is known here.

## ECONOMIC APPLICATIONS OF SEA-WEED.

The value of sea-weeds to man, whether in agriculture, the arts, and even as articles of food, is considerable, but yet this extensive field is comparatively ungarnered.

A very interesting paper was read on the application of sea-weed by Edward C. C. Stanford, F.C.S., before the Society of Arts, on the 12th of February, 1862, from which I shall quote, by the author's permission, many interesting details.

Sixty years ago it would have been difficult to persuade a botanist to include one of the Marine Algæ in his herbarium, so worthless and insignificant were they then esteemed; now they are numbered amongst the choicest dried collections from the vegetable kingdom. The seaside-loving public, who seek health and relaxation in marine breezes, have ample opportunities of seeing them in the freshness of life, and of watching their growth in the shallow pools that are left by the receding tide on our coasts; and we have all become familiar with their diversity of colour and delicate beauty. But as the beauty of the algæ has been despised, so their utility appears to have been generally discredited. The Latin poets gave alga the prefix of *inutilis*, and Dr. Johnson has been often quoted, perhaps rather unfairly, as having included them in his "plants that are noxious and useless." The first important application of sea-weeds was made about the middle of the last century: it con-

sisted in burning them for the ash, as a source of soda; but barilla from abroad entered our market, and the tall chimney of the alkali-works rose up in competition against them, and sea-weeds were again at a discount. Then the discovery of iodine was made, and the burning of sea-weeds became a necessity; and even now we are mainly indebted to this humble source for the means we possess of borrowing the sun's light to paint his own image. Nevertheless, it must be admitted that the chemistry of sea-weed has been but imperfectly studied, and by far the greater part of the rich wreck of marine vegetation annually deposited on our island shores remains unappropriated.

I shall first review the various applications of sea-weed at present made, and then proceed to point out the best method of bringing our marine harvest to the national barn. I must premise here that under the collective term sea-weed, I include all plants growing in the sea and thrown up on the shore, as I shall have to speak of some that are not true algæ. The present principal economic applications of sea-weeds are, as manure, as food, or medicine, and in the manufacture of kelp; but we may notice also a few other suggested uses, retrospective and prospective.

*Sea-weed as Manure, &c.*—The value of sea-weed as manure is most appreciated in the Channel Islands; the "varec" or "vraic," as the weed is there called, is considered so valuable, that special laws are enforced for its regular collection and fair distribution amongst the agriculturists, many of whom use no other manure. "*Point de vraic, point de haugard*" (no sea-

weed, no corn-yard), has passed into a local proverb. The sea-weeds are of two kinds, *vraic venant*, and *vraic scié*. The former is the drift-weed cast up by the stormy seas, on their sandy but rock-bound shores: this is the most valuable, consisting chiefly of *Laminaria digitata* and *L. saccharina*, very rich in iodine and salts of potash. It is allowed to be raked up and collected all the year round, from sunrise to sunset, the time being prolonged during the winter to 8 P.M. This is the constant employment of the cottagers on the coast both of Guernsey and Jersey, and the collection is at its height in stormy weather. The work is very laborious, the large wooden rakes used being often torn out of the hands of the *vraiqueurs* by the waves. The beautiful sandy bays which abound in these islands are the scenes of their toil. The weed is either thickly spread on the land, and ploughed in fresh with a deep plough, or dried on the beach, and burnt on the cottagers' hearths as fuel; certainly not on account of the cheerful appearance of the fire, or its pleasant odour, but because the charred ash thus produced sells at 6*d.* per bushel for manure. The fire smoulders quietly; it is never extinguished, but constantly renewed, and the whitest of all smoke ascends night and day from the rude chimneys of these humble dwellings. The *vraic scié* is the 'cut weed,' cut off the rocks at low tide, consisting principally of *Fucus vesiculosus*, *F. serratus*, *F. nodosus*; the time of cutting it is fixed by law, at Guernsey, from July 17th to August 31st; and at Jersey twice a year, commencing March 10th and June 20th, and lasting about ten days each time. The summer cut-

ting is made a regular holiday in both islands, and to the young "vraiqueurs" of both sexes it is an occasion of great festivity.

It is computed that about 30,000 loads of vraic of all kinds are annually obtained from the rocks and bays of Guernsey and the adjacent small island of Herm, valued at £3,000, or 2*s.* per load; this is a mere nominal price, if the value of the potash and iodine alone be taken into consideration. The quantity of vraic collected at Jersey is, probably, quite equal to that obtained in Guernsey; but it seemed to me, during a recent visit, that the vraic used was generally not so rich, and that more is burnt and less ploughed in than at Guernsey. In one cottage I found the mother and all her family employed in drying and burning weed, composed entirely of the marine plant known as the grass-wrack, *Zostera marina* (Nat. ord. *Naiadaceæ*), one of the poorest and most common of our sea-weeds; the best front parlour was given up to its ignition: this was accompanied by an insufferable odour, which the lady informed me was esteemed very healthy. This is a prevalent opinion amongst the peasants wherever sea-weeds are burnt, and in this case I must confess that her statement was fully borne out by appearances, if I might judge by the rosy cheeks of her little assistants. She was getting the ash ready in a hurry to sow with corn on the following day, having, no doubt, the proverb before quoted weighing on her mind. The best sea-weeds are stacked in Jersey; a dozen stacks of "vraic venant" thatched over are common objects in a farm-yard, and small barns are given up to its storage when dry. The

value set on vraic may be judged of by the fact that the inhabitants of Sark, having none on their island, import it in fishing-boats from Herm, five miles distant; fifty Guernsey and Sark boats may be seen at once at Herm engaged in this traffic; and those who are acquainted with the precipitous nature of the rocks of Sark and its dangerous currents, will appreciate the value of vraic in that island. "Drift weed" is also largely used in Ireland, as the only manure for the potato crop; this is interesting, because the potato requires a considerable supply of potash. This alkali can hardly, however, be required in the Channel Islands, as the granitic subsoil would, in disintegration, furnish it in abundance; it is probably the earthy phosphates that render the weed so fertilizing there. This is borne out by the fact that the lixiviated sea-weed ash, from which the alkalies have been removed, meets with a ready sale in Guernsey, and is esteemed indeed richer, no doubt on account of the increased per-centage of phosphates. The agriculture in the western islands is also enriched by this manure, and some of the tangle is brought into Oban by fishermen in boats, and sold at 1*s.* per load. On the south-east coast of Fife it is laid on the stubble at the rate of twenty cart-loads an acre, and ploughed in; the clover crop never fails, and this is a crop requiring much phosphate of magnesia, an important constituent of sea-weed ash. In the Isle of Lewis twenty tons of sea-weed are considered ample manure for a Scotch acre. The agricultural produce of the Isle of Thanet, in Kent, is said to have been tripled by the use of this manure; and the farms on the Lothian coasts let

for twenty or thirty shillings more rent per acre where the tenants have a right-of-way to the sea-coast, where the weed is thrown ashore. In England, generally, however, sea-weed is little valued by agriculturists as an actual manure, and appears to be regarded rather as an economical and useful covering to protect turnips and other roots from winter frosts. Farmers object to its bulk and expensive carriage, particularly now so many portable artificial manures are offered for sale, and recommended so strongly by their manufacturers as possessing great fertilizing value in a small compass. There can be no question that though many of these are good, some are perfectly useless, except to line the pockets of the vendor; and the farmer would do well to turn his attention to the composition of sea-weed ash, which really does contain all the constituents of a good manure in a small bulk.

On many shores, the harvest of the deep is anxiously looked after and as carefully attended to as that of the land, and, indeed, the last is often dependent on the former for its abundance.

All kinds of sea-weed are applicable for manure. On many of our coasts, as along the west of Ireland, the poorer classes are almost entirely dependent for the cultivation of their potatoes on the manure thrown on their rocky shores by the frequent gales of wind. After a storm they may be seen congregating in numbers from the surrounding country, with horses and cars, or with panniers; and the poorest, who cannot afford the assistance of a donkey, are themselves bearers of burdens, eagerly collecting what is thrown up and

carrying it beyond the reach of the tide. The kinds preferred for potatoes are the large and succulent *Laminareæ*, and when these are abundant, other kinds are neglected. These are often carried many miles into the interior, and being mixed with sea-sand, form an excellent manure, which must, however, be used quickly, as it very soon decomposes, and the gases it gives birth to are consequently lost to the ground if it be suffered to lie open.

A process has been recommended by Dr. Stenhouse (*Philosophical Magazine*) for the manufacture of acetic acid from wet weeds by fermentation. His experiments were conducted with some of the fuci; these were mixed with lime, and kept moist: at a temperature of 90° Fahr. he obtained by distillation with sulphuric acid an average of 1·5 per cent. of anhydrous acetic acid: it is contaminated with butyric acid. This might, however, be separated and turned to account in the manufacture of butyric ether or essence of pine-apple. I have not heard of this suggestion being carried out, but it might be tried on those weeds intended for manure. In this case the best method would be to ferment them in pits with lime or chalk, at the ordinary temperature in the summer, leaving each portion in for two or three months, and supplying its place by a fresh load until the lime was saturated; the liquid would then be pumped out, evaporated to dryness, the residue sold as crude acetate of lime, and the weed carried to the manure-heap. The whole process could be rudely and economically carried on by an agriculturist near the sea.

The weeds having been previously employed in the manufacture of vinegar, would not very materially interfere with their use for manure. For if the fermented weeds and the salts remaining in the stills were spread upon the land, I apprehend they would prove almost as useful in an agricultural point of view as the fresh sea-weeds would have done.

From Dr. Stenhouse's experiments it results that when the weeds are fermented at the ordinary temperature of Scotland during the summer months, the process goes on much more slowly, and yields a considerably smaller product than when the temperature is retained at about 90° Fahr. Should any person, therefore, think of manufacturing acetic acid from sea-weeds, either in Great Britain or in any of the northern countries of Europe, I would advise him to employ so much artificial heat as to produce a constant temperature of from 90° to 96° Fahr. I should suspect, however, that in the southern portions of Europe, at least during the summer months, and in tropical countries, artificial heat might probably be dispensed with.

Sea-weeds, as might be supposed, from their growing in salt-water, are exceedingly rich in mineral matter. They contain some 38 per cent. of salts; phosphate of lime and phosphoric acid are also present in them. In short, in this form of vegetable matter, we have a certain quantity of what crops require; so that if we lay it on land, or plough it in, it is found to bo productive of great benefit.

In the Isle of Arran the Duke of Hamilton assigns

to each of his tenants a certain portion of the sea shore, according to the extent of his land, from which he may collect sea-weed for manure. In Ireland, as already stated, it is still more valuable, being the chief manure for thousands of acres of potato-ground.

The value of sea-weed, where obtainable within an easy distance, is now so well recognized as to make it worth looking after. In many coast villages, where allotments and gardens abound, the right to gather it is no small privilege; but there appears to be some doubt as to who have this right. For example, one person says he succeeded to an allotment, situated less than half a mile from the sea, and detached from the farm which extends down to the sea. In his lease the farmer has the liberty to gather sea-ware, so far as the landlord himself has right. Acting on this, he forbids any one gathering but those who treat with him. The popular view of the case is quite opposed to the farmer's. It is said that a landowner is bounded by high-water mark, all beyond being claimed by the Crown, and that, consequently, all wrack deposited by the waves between high and low water can be taken all and sundry unchallenged, except by the Crown. This seems borne out by a parallel decision of the Supreme Court of Scotland (Hall *v.* Whillis, 1852; see *Shaw's Digest*, vol. iii. p. 382), by which it was held, that the owner of lands adjacent to the sea could not exclude the public from gathering shellfish below high-water mark, provided they could do so without trespass on the lands. It occurs to me that there are other decisions in point, and that one was lately alluded to in

the papers in which, if I remember rightly, the Marquis of Lansdowne was concerned.

A deposit of sea-weed of a million tons or more, nearly equal to the best guano, has been going on for centuries at the Isle of Foulney, the outlet of the tidal river, ten miles from Ulverstone: although it is little used generally, it has been successfully employed on a farm there for the last ten years. The efflux of the tide has brought it off the stones of Walney Isle for some fifteen miles round the south point of Walney to Foulney.

Sea-weed is used largely as manure in Cornwall and the Isle of Man. It is rotted in heaps, covered with ditch and road scrapings, weeds, &c. It is not deemed a powerful manure, for it contains a very large proportion of water, and its mineral constituents are chiefly soda, with a little sea-salt, and a very small proportion of iodine. Probably the kelp-weed, dried, charred, and ground, would be useful to disintegrate the waste fish for manure, and would add to the value of the compound. A proportion of fish, salt, and of dried sea-weed burnt to charcoal, would be a powerful manure, and the phosphates could be supplied with ground or burnt bones.

An analysis, by Professor Way, on decomposed and concentrated sea-weed, as a substitute for guano, gave the following results (to be reduced to a powder and drilled in):

| | | |
|---|---|---|
| Organic matter .... | 65·62 | Equivalent to near 4 per cent. of ammonia. |
| Soda .............. | 13·65 | |
| Soluble salts ........ | 16·00 | |
| Nitrogen ............ | 3·23 | |

The colouring matter in many sea-weeds may be

developed by some alkali previously steeped a fortnight in stale urine, frequently stirred, &c. Red sea-weed, often found in abundance on some of our coasts, probably contains bromine, seldom if ever found on land, but most valuable in the arts and sciences, and one of the treasures of the deep.

Mr. S. Osler, of Yarmouth, informs me that sea-weed is used extensively for manure on the Cornish coast, particularly near Penzance, for the growth of early potatoes, and the land in consequence brings almost fabulous prices; and another description of sea-weed, called "dulse," is made use of as an article of food on the Scotch coast; and I have, during many years' Scotch travel, seen it exposed for sale in the markets of Dundee and Aberdeen; and the comparative absence of rheumatic affection in these districts is attributed to its use, on account of the iodine contained therein. Hydriodate of potassia, in small white granular crystals, is largely manufactured in France from sea-weed, and there is a manufactory of a similar article in Aberdeen.

In a work published by Mr. H. Platt in 1601, styled "The New and Admirable Art of Setting of Corne," the author says, "Sea-kelps and sea-tangle, and other sea-weeds, are found by experience to enrich both arable and pasture ground exceedinglie." While two hundred and sixty years ago an Englishman thus drew attention to their uses, it is surprising to find how little investigation has since taken place.

In the town of Galway, boats discharge their cargoes of sea-weed, collected from Slyne-head, a place fifty or sixty miles distant; and purchasers for these

cargoes often come from thirty miles inland to fetch it.

Sea-weeds supply both organic and saline matter to the soil. Although their effects are considered to be transient, the marine algæ are important fertilizers. They are peculiarly valuable, as the salt contained in them destroys foul weeds. The cultivated fields of the coasts are almost free from those noxious plants that infest the lands of the interior. Sea-weeds are applied to the land in small quantities on almost all the coasts of the British American provinces, and especially by the fishermen, who depend upon their potato and cabbage patch for a part of their subsistence; but this kind of manure is generally neglected by farmers in situations where it might be cheaply obtained, and the high price of labour there has operated against its more extended use. In Denmark, sea-weed is used for fuel, and in some of the Baltic countries as a packing material and for stuffing articles. The *Ulva marina*—" Alva" of the shops—is even now an extensive commercial article.

The French Government has ordered the systematic gathering of the sea-weed on the coasts of Normandy and Brittany, to serve as wadding for cannon. The weed is washed and dried to prevent the absorption of damp, and it has the advantage of being elastic and incombustible, and keeps the iron cool.

A French engineer in the south of France, M. Lagout, proposes the employment of sea-weed, but more particularly the algæ, that exist in great abundance in the salt lakes of Languedoc and Provence, for a lining of roofs and walls. He states that among the useful properties possessed by these marine plants are the

following :—They are bad conductors of heat and cold, and, when pressed into a compact mass, of sound also. They are almost incombustible, and, even when they do burn, they never produce a flame, but smoulder until they gradually and spontaneously become extinguished; lastly they afford no harbour to vermin. In the south of France the inhabitants of the top floors of houses are obliged to resort to a variety of expedients to keep down the temperature of rooms when the sun shines; and, in fact, the upper story under the roof is seldom inhabited. It is suggested to place a thick layer of these marine plants between the roof and the ceilings of the rooms, which will not only prevent the transmission of heat during the summer, but will also, during winter, prevent the penetration of cold. In the side-walls layers of algæ are proposed to be built up for the same purpose, and also to prevent the transmission of sound. The marine plants are in all cases to be freed from saline particles, or "unsalted," if the expression may be allowed; but whether the algæ will ever cease to have a great affinity for the humidity of the atmosphere is not stated. Should they be found still to retain this quality, it will not only keep the walls damp and render apartments unhealthy, but they would likewise furnish an element for the rapid deterioration of the structure.

Mannite, or marine sugar, is obtained from many sea-weeds. When some marine algæ are dried in the open air, they produce this efflorescence on their surface. Such are the *Laminaria saccharina*, and *digitata*, *Rhodomenia palmata*, *Halidrys siliquosa*, *Fucus nodosus*, *vesiculosus*, *serratus*, &c.

Dr. Stenhouse has determined the quantity of mannite in some sea-weeds as follows :—

| | | |
|---|---|---|
| Laminaria saccharina | .. | 12 to 15 per cent. |
| Halidrys siliquosa .. | .. | ·5 to 6 ,, |
| Laminaria digitata .. | .. | 4 to 5 ,, |
| Fucus serratus .. | .. | rather less. |
| Alaria esculenta .. | .. | about the same. |
| Rhodomenia palmata | .. | 2 to 3 per cent. |
| Fucus vesiculosus .. | .. | 1 to 2 ,, |
| Fucus nodosus .. | .. | nearly the same. |

This production of mannite appears to be always the result of a peculiar fermentation, the effect of which is to deoxidize the vegetable mucilage and convert it into mannite. Many marine algæ contain such large quantities of mucilage that some naturalists have endeavoured to make use of this product in the arts. Thus Brown (*Edin. Phil. Journal,* xxvi. p. 409) found that by prolonged ebullition with dilute sulphuric acid this mucilage was converted into *arabine.*

The gelatine or mucus differs greatly in consistency in different species of algæ. In *Gigartina, Chondrus,* &c., it is so firm as to give those plants the consistence of cartilage ; and in these it is immediately dissolved in hot water.

*Sea-weed as Food.*—An esculent sea-weed, *Plocaria candida* or *Gigartina lichenoides,* which obtained some medicinal and general repute in this country about twenty years ago, under the name of Ceylon Moss, is collected about Jaffna, on the eastern coast of Ceylon. It is not, however, confined to this spot, but appears to be met with on many of the islands of the Indian Archipelago, and probably in

the Chinese seas. Rumphius, in his "Plants of Amboyna," states that it loves the open sea, and is abundant on the eastern part of Leytimore, on Œliassara, on the flat island of Nussa Cassa in the Bay of Caybolba, and on all the rocky shores of Bally, and the eastern side of Java.

Mr. Crawfurd, in his "History of the Indian Archipelago," without mentioning the coasts where it is collected, briefly observes that it forms a part of the cargo of all the Chinese junks.

Upon the esculent properties of this sea-weed it is recorded by Rumphius, that it is generally eaten raw, being merely macerated or washed in fresh water and then squeezed so as to remove a considerable part of the mucilage and saltness. Thus cleansed it is eaten with atsiar or dabbo-dabbo, or a sauce prepared with lemon-juice and a little ginger. It may also be dried after it has been macerated, and in that state be preserved a long time, and cooked gently at any future opportunity. But if boiled violently, or kept too long in lemon-juice, it loses most of its goodness and nearly melts away into a mucus.

The same nutritious properties which render this plant so valuable to the Ceylonese, are found by the Japanese in *Laminaria saccharina;* by the natives of Chili in *Durvillæa edulis*; by the Icelanders in *Halymenia palmata*, the old *Fucus ovinus* or saccharine fucus; and by the Irish in *Chondrus crispus.*

Mr. Previté, during his residence in Ceylon, found the plant largely employed to furnish a paste or glue, for which purpose it has long been used by the Chinese.

The species most commonly employed in that country as a gum or size to strengthen or varnish paper, and to whiten or give a gloss to gauze or silk, is *Gigartina tenax*, and *Gigartina lichenoides* is little inferior to it.

Some of our most learned botanists, philosophers, and physicians, have long since taught us to look for considerable advantages yet to be reaped from the various kinds of mosses and sea-weeds. Linnæus used the following language :—" Natura nihil frustra creaverit, posteros tamen tot inventuros utilitates ex Muscis auguror quot ex reliquis vegetabilibus." The authority of Ray, of Buddle, Dale, Petiver, Morison, Sherard, Richardson, Vaillant, Micheli, Haller, Dillenius, Quarin, and Hartmann, may be taken as sufficient evidence that these mosses, of such deep importance to man, have not been altogether overlooked ; we find, too, in our medical writers, mention of several of the humblest cryptogamic plants as adjuvants in the cure of disease ; amongst them, *Muscus pulmonarius, Lichen terrestris cinereus, Usnea, Cetraria islandica, Chondrus crispus*, and *Laminaria saccharina.*

The infinite variety of sea-weeds must afford sources of different medicinal and dietetic agency, and that they are deeply prized amongst the eastern nations is fully proved from the experience of travellers.*

The following extract from the Voyages of Barrow proves the high estimation in which they are held amongst the Asiatic nations :—

"The gelatinous substances derived from the sea,

* Dr. Sigmond on Ceylon Moss.

whether animal or vegetable, are considered by the Cochin-Chinese amongst the most nutritious of all aliments, and on this principle various kinds of algæ or sea-weeds, particularly those genera which are known by the name of Fuci and Ulvæ, are included in the list of their edible plants.

"In the populous islands of Japan, the natives of the sea-coast derive part of their sustenance from various kinds of sea-weeds, and from none more than that species of Fucus which is called *saccharinus*. It would appear from Thunberg's account of its leaves being used to ornament and embellish packages of fruit and other presents offered to strangers, that this plant is in high estimation. The Chin-chou jelly of China may probably be partly made of the *Fucus saccharinus*. It would appear from samples brought to England, that the leaves from which this jelly is made are taken from three or four species of this extensive genus."

The sea-weed, stigmatized by the Romans as *vilis* and *inutilis*, is likely not only to be useful in the arts and sciences, but by the skill and experience of the judicious investigator to be rendered of the greatest importance for the preservation and prolongation of human existence. Java, Sumatra, Macassar, and Ceylon, yield large quantities of these; some of which will become ere long articles of great consequence in trade.

One of the recommendations of this Ceylon sea-weed is the facility and the quickness with which it may be prepared for use. It demands no culinary skill, nor is much time occupied in giving it the form which is

required. The following recipe for the preparation of the jelly is quite explanatory of the facility attending it.

Put into an open stewpan half an ounce of the prepared moss and a quart of boiling water. Boil briskly for twenty-five minutes, or until a spoonful of the liquid forms into a firm jelly within two or three minutes after it is taken from the pan. Flavour with wine, a little cinnamon, lemon or orange juice and peel, and sweeten according to taste. Boil the whole for five minutes, and pass it two or three times through a jelly-bag or doubled muslin. Leave it undisturbed, and it will become a firm jelly in ten minutes. If it be required perfectly clear for table use, add the white of two eggs beaten up into a whip before the second boiling, and allow it to stand for a few minutes away from the fire, with some hot coals on the cover of the pan. When clear, pass it through the jelly-bag, and leave it to congeal. Should the jelly be required particularly firm, add an ounce of the moss to the quart of water. The moulds best adapted for this jelly are of white earthenware, to which it adheres much less than to tin or copper. No heat is required to separate the jelly from the mould ; but a little care is necessary in turning it out, on account of its brittleness, or want of elasticity. One pound of the prepared moss will make sixteen quarts of jelly.

Amongst the peculiar advantages of the Ceylon moss jelly is the rapidity with which coagulation takes place, its durability, and its delicate and nutritious qualities. The fluid gelatinizes within ten minutes

after boiling, long before it becomes cold. In this state it will remain unaltered for many days, even in the hottest weather; a circumstance which gives it a great advantage over every form of animal jelly.

The jelly is agreeable to the palate, is delicate, and marked neither by taste nor smell, so that at the most fastidious moment of caprice it cannot be considered objectionable; it is quickly soluble in the mouth, and sits lightly on the stomach; it may be flavoured according to the wish of the invalid.

Sometimes two drops of the syrup of balsam of tolu, of marsh-mallow, of mulberry, or violet, or of strawberry, may be employed to a pint, to vary the flavour. When a gentle diffusible stimulant is admissible, the same quantity of compound tincture of cardamoms, of cinnamon, of maraschino, of noyeau, of parfait amour, or of essence of roses, may be judiciously prescribed. A tablespoonful of the juice of the pineapple, without any additional flavouring matter, gives the most delicate flavour. When something richer may be required, a blancmange or Indian cream may be produced from the Ceylon moss in the following manner.

To make a quart of blancmange or Italian cream, add to an ounce of prepared moss a quart of boiling water, and reduce by boiling to one third. Strain this, and add it, while fluid, to the milk and other materials instead of isinglass, and pour the mixture immediately into the mould. The moss, boiled in milk or whey, and simply sweetened while boiling, and strained, forms a very nourishing and strengthening article for

children, and for all delicate constitutions, especially if taken in the morning.*

In 1857, my friend Dr. Macgowan, now in England, sent home from Ningpo a collection of edible algæ in use in China, of which I have been favoured with specimens. They consisted of eight varieties, viz. :—

1. Tan-shwui grass, *Laurencia papillosa*, Greville, so named from the place, on the coast of Formosa, whence it is procured. It is used for making Yang-tsai (ocean vegetable), see No. 8. This sea-weed has been very carelessly collected, and is much mixed with other substances.

2. Niu-mau (ox-hair) grass, *Gelidium corneum*, Lamouroux, made into an iced jelly, and sold in the streets in hot weather, sugared.

3. Hai-tsai (sea-tape), *Laminaria saccharina*, Lamouroux. This is sent into the interior, wherever fossil coal is used. It is considered corrective of the deleterious exhalations of that fuel. It is usually boiled with pork. This kind comes from Shantung province.

4. Tsz-tsai (purple vegetable), *Porphyra vulgaris*, var., Agardh. Often eaten as it is to give relish to rice, or cooked.

5. Fah-tsai (hair-vegetable). This has the structure of a Melanosperm, and may probably be *Chorda filum*, Lamouroux. Boiled either with animal or vegetable articles, it forms a broth. The gills are also eaten with sugar.

6. Ki-tsai (henfoot vegetable). *Gracilaria crassa* (?) Cooked with soy or vinegar. It is also used by the

* Sigmond on Ceylon Moss.

women to make the hair glossy and to strengthen it. It is an inferior kind of agar-agar

7. Sea-tape from Japan, *Laminaria saccharina*. This is preferred to the former.

8. Yang-tsai (ocean vegetable). This is the article marked No. 1, blanched, &c. Within the last few years, the Chinese have learnt the art of preparing it from the Japanese. It is the strip sea-weed isinglass that has recently appeared in our markets from Japan.

Under the incorrect name of Japanese isinglass there has been of late years imported into London from Japan a quantity of prepared sea-weed of two kinds; the first having the form of compressed, irregularly four-sided sticks, apparently composed of shrivelled, semi-transparent, yellowish-white membrane; they are 11 inches long by from 1 to $1\frac{1}{2}$ inch broad, full of cavities, very light (each weighing about three drachms), rather flexible but easily broken, and devoid of taste and smell. Treated with cold water, a stick increases greatly in volume, becoming a quadrangular spongy bar with somewhat concave sides, $1\frac{1}{2}$ inch wide. Though not soluble in cold water to any important extent, the substance dissolves for the most part when boiled for some time, and the solution, even though dilute, gelatinizes upon cooling.

The second kind resembles the preceding in all its properties, but its form is very different, it being in long shrivelled strips, about $\frac{1}{8}$ of an inch in diameter. These strips when immersed in water speedily increase in volume, and are then seen to be irregularly rectan-

gular. This substance in colour is usually whiter than the preceding; it is also more readily soluble, clearer, and altogether a more carefully manufactured article. The substance under notice, in all its forms, is used by the Europeans in China as a substitute for true isinglass, for which many of its properties render it highly efficient. That which is, perhaps, most distinctive, is its power of combining with a very large proportion of water to form a jelly. This property is due to the principle named by M. Payen gelose, of which the Japanese sea-weed product mainly consists. The jelly formed by boiling this sea-weed product, or crude gelose, in water, and allowing the solution to cool, requires a high temperature for fusion, differing in this respect from a jelly made of isinglass, which readily fuses and dissolves in warm water. This character occasions a peculiarity in the taste of culinary jellies made of the new material, inasmuch as they do not dissolve in the mouth as ordinary animal jelly. The jelly of gelose is but little prone to undergo change; so little indeed, that sometimes, under the name of *sea-weed jelly*, it is imported to this country from Singapore, sweetened, flavoured, and ready for use, and in this state it may be kept for years without deterioration. Gelose differs from animal gelatine in not precipitating tannic acid; from starch-jelly, in not being rendered blue by iodine; from gum, by its insolubility in cold water and its great gelatinizing power. From the mucilage of *Chondrus crispus*, named by Pereira *carrageenin*, it appears to differ chiefly in its power oi combining with a greater amount of water to form a jelly, which is not the case with carrageenin.

Of the botanical origin of crude gelose, or Japanese isinglass, and the mode of its preparation in Japan and China, we are not yet well informed. M. Payen finds it may be extracted from many species of sea-weed, but especially from *Gelidium corneum*, Lamouroux, and *Gracilaria lichenoides*, Greville; the former of which yielded in his experiments to the extent of 27 per cent.

One part of gelose dissolved in 500 parts of boiling water will afford, upon cooling, a colourless, transparent jelly; thus forming ten times more jelly than a like weight of the best animal gelatine. In order, therefore, to produce a jelly of equal consistence, it would be only necessary to employ the tenth part of what is necessary when isinglass is used. Jellies prepared from species of *Gelidium*, *Laurencia*, &c., are much employed for food in China, Japan, &c.

It appears, however, that several other sea-weeds are likewise employed by the Chinese, some of them on account of their gelatinous qualities; such are—*Laminaria papillosa*, Greville, *Laminaria saccharina*, Lamouroux, *Porphyra vulgaris*, Agardh, and a species of *Gracilaria*, apparently *G. crassa*, Harvey (Alg. Zeylan.). Another sea-weed, largely collected in the Indian archipelago for exportation to China, and which is one of the species known as agar agar, is *Eucheuma spinosa*, Agardh.*

Sea-weed, collected from the rocks that surround the Sooloo islands, is exported to China with tripang. One hundred and ten piculs of sea-weed were imported into Canton in 1856, valued at 2 dollars the picul.

* D. Hanbury, in Pharm. Jour. vol. xix. p. 508.

Between the 1st November, 1858, and the 23rd May, 1859, I observed, by the Japanese prices current, that 8,690 piculs (of nearly 1¼ cwt. each) of sea-weed were exported from the single port of Nagasaki to China.

*Nostoc edule* is eaten in China, &c., and *Nostoc Arcticum* forms a valuable article of food in the Arctic regions. It is said by some to be far superior in this respect to Iceland moss. Other specimens possess similar properties.

There are many other algæ used extensively as food by the Chinese, the botanic names of which are not known; but from the opening up of China and Japan to our countrymen, we may shortly expect much information on this subject. The Chinese are evidently the algæ-consuming nation, and there is no doubt that, in our own country, the algæ as food have been much neglected. Dr. Davy found the proportion of nitrogen in 100 parts of the dry plants to be as follows:—

| | |
|---|---|
| Laminaria digitata .. .. .. | 1·583 |
| Rhodomenia palmata .. .. .. | 1·656 |
| Gigartina mamillosa .. .. .. | 2·198 |
| Fucus vesiculosus .. .. .. | 2·397 |
| Alaria esculenta .. .. .. .. | 2·424 |
| Chondrus crispus .. .. .. .. | 2·500 |
| Iridæa edulis .. .. .. .. | 3·088 |
| Porphyra laciniata .. .. .. | 4·650 |

This is a very large per-centage, and equal to any of our other vegetable esculents. Researches directed especially to the algæ as food would doubtless widely extend our present number of edible species. It may be remarked, however, that those already enume-

rated require much cooking and flavouring, in order to induce the national palate to acquire a taste for them; that John Bull, although so truly a man of the sea, certainly does not take kindly to an Algine diet, and there is no doubt, if it can be shown to his entire satisfaction, that a lucrative manufacture of chemical products can be conducted wherever there are sea-weeds, hitherto esteemed useless, he would prefer vegetables grown in an ordinary garden, to dulse, laver, or any other such marine delicacy, particularly if the weeds can, by any means, be coined into money.

That scourge of our seamen, the scurvy, has been considered by many scientific men to be due to the insufficient supply of potash in the salt meat, the juice of which has diffused into the brine. The juices of limes and lemons are largely imported for its cure; if these act, as is supposed, by virtue of the potash they contain, a far better source may be found in the marine algæ. Let the most edible of these be selected for their use, and cooked as vegetables; they are well worth a trial, as they keep when dried, or may be often obtained fresh at sea; and if successful, would save large sums to the nation, at present annually expended in the juice of limes and lemons. Or, if the sailors cannot be induced to acquire a relish for marine vegetables, let the chloride of potassium, prepared from them, be used with common salt in due proportion for salting their provisions. The admixture could not be detected, and there can be no doubt that such a brine would be far superior, in its effects on the meat, to that commonly employed, where we

take the juice containing the potash salts out of the meat, and substitute for it a saturated solution of chloride of sodium, with occasionally a small portion of nitre.

Several species of Fuci are eatable, owing, doubtless, to the large quantity of gelatinous matter that they secrete. The young stalks of the great oar weeds, *Laminaria digitata* and *saccharina*, are eaten. In Asia, *Sargassum acanthocarpum* and *pyriforme*, with *Laminaria bracteata*, and, in the Sandwich Islands, *Sargassum cuneifolium* are also used for food. When stripped of the thin part, the beautiful *Alaria esculenta* forms a portion of the simple fare of the poorer classes of Ireland, Scotland, Iceland, Denmark, and the Faroe Islands. The large *Laminaria potatorum* of Australia furnishes the aborigines with a great portion of their instruments, vessels, and food. On the authority of Bory de St. Vincent, the *Durvillæa utilis* and other *Laminaridæ* constitute an equally important resource to the poor on the west coast of South America. In some of the Scottish islands and the west of Ireland, horses, cattle, and sheep feed chiefly upon *Fucus vesiculosus* during winter.

This fucus affords an abundant and wholesome sustenance to the horses and cattle of the people of Norway, who call it kine tang, or cow-weed. The people of Gothland boil it, and, mixing it with coarse flour, feed their pigs with it; whence they call it swine-tang. In the Channel Islands it is used as fuel and employed in smoke-drying pork and fish. *Fucus serratus* is also used as

winter provender in some northern countries, and in Norway is called bred-tang, being given to the cattle sprinkled with meal. Its most common use, however, is to spread over lobsters, shell-fish, &c., in order to keep them fresh when sent into the country. For this purpose it answers better than *Fucus vesiculosus*, being of a less mucous nature and consequently less liable to run into fermentation.

For cattle food, the use of sea-weed might be more extensively employed; since they thrive on nitrogenous roots containing phosphate of lime and salts of potash. The algæ are strictly comparable to these, with the addition that they contain common salt, which cannot be considered a disadvantage. We know that many species are eaten by cattle with great relish; the economy of the food is obvious, and its nutritive value need not be dwelt on.

*Porphyra laciniata* and *vulgaris* are stewed and brought to our tables as a luxury, under the name of Laver; and even the *Ulva latissima*, or green Laver, is not slighted in the absence of the *Porphyræ*.

*Ulva compressa*, a common species on our shores, is regarded, according to Gaudichaud, as an esculent by the Sandwich Islanders.

Sowle bread is prepared in Swansea from a sea-weed obtained in that locality. Mr. W. Summerby, in a communication to the *Gardeners' Chronicle*, December 14, 1861, says, "Although it did not appear very palatable to the eye, yet my inquisitiveness was such that I was induced to purchase some, and I found it when cooked to be a very agreeable esculent, and very similar in flavour to the most delicious of

the Brassica tribe; in the market it appeared much like a semi-soluble glue; when cooked, its original form as a vegetable was clearly observable. It is more usually called, in Glamorganshire, Laver bread. It is the *Ulva lactuca*, which is found in abundance on that coast, and is considered by some persons a great delicacy when boiled and flavoured with vinegar or lemon-juice, or fried in small flat cakes."

Sea-weed is often still employed in Ireland and Scotland as food for man and beast. The cry of "Dulse and Tangle" used to be as common in the streets of Edinburgh and Glasgow as that of water-cresses now is in London.

Perhaps, by the aid of good condiments and a good appetite, all kinds of sea-weed might be made palatable, verifying the good old Scotch proverb, "If you boil *stanes* in butter, you may sup the broo."

Kampfer ("Account of Japan") states: "Of all the soft submarine plants, there is hardly one but what the natives eat. Fishermen's wives wash, sort, and sell them, and they are likewise very dexterous in diving them up from the bottom of the sea in twenty to forty fathoms (?) depth."

Tsantjan, a preparation of *Fucus cartilaginosus*, is used as an esculent in the East instead of edible birds'-nests. It was at one time supposed that these nests were formed with layers of sea-weed, but analysis has shown that they are of animal origin and formed by the birds.

The *Laminaria saccharina* is called by the Japanese Komb or Kohn, or sometimes Kosi. Cleansed and dried, it is eaten, though very tough, either boiled or

raw—in the latter case, cut into strips, which are folded in little squares, a considerable number of which are usually strewed on the small tables or salvers, on which the complimentary presents, so common with the Japanese, are offered. These presents, generally of trifling value, are always accompanied with a complimentary paper (so called) folded in a peculiar manner, and having slips of this fucus pasted to both ends of it.

According to Mr. Neill, the old stems of *Laminaria digitata* are applied "to rather an unexpected use,—the making of knife-handles. A pretty thick stem is selected and cut into pieces about four inches long; into these, when fresh, are stuck blades of knives, such as gardeners use for pruning or grafting. As the stem dries it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that when tipped with metal they are hardly to be distinguished from hart's horn."

As human food, many of the Algæ have, as we have already seen, in different countries, been used both as articles of luxury and resources in time of scarcity. Of British species, *Alaria esculenta*, *Rhodomenia palmata*, *Chondrus crispus*, *Gigartina mamillosa*, *Laurencia pinnatifida*, *Iridæa edulis*, *Porphyra vulgaris* and *laciniata*, and *Ulva latissima* have been more or less used. *Rhodomenia palmata*, the "dulse" of the Lowland Scotch, "duillisg" of the Highlanders, and "dillisk" of the Irish, is still much eaten in many parts of Ireland

and Scotland; it is prepared by being washed and dried, and is eaten raw—chewed like tobacco. It has a sweetish taste. That which grows on rocks or mussel-shells, called "shell dillisk," is preferred, as it is less tough and coarse than what grows on *Laminariæ.* In Norway it is greedily eaten by sheep and goats, which flock to the shore to seek it, whence Ganner once named it *Fucus ovinus.* According to Lightfoot, it is used in Skye as a remedy in fevers to promote perspiration, being boiled and mixed with butter. It is sometimes, but seldom, fried, a mode of cooking which answers better with *Iridæa edulis,* which is too tough to be eaten raw.

In the islands of the Archipelago, dulse is a favourite ingredient in ragouts, to which it imparts a red colour, besides rendering them of a thicker and richer consistence. The dried frond, like many other Algæ, when infused in water, exhales an odour resembling that of violets; and Dr. Patrick Neill mentions that it communicates this flavour to vegetables with which it is mixed.

*Porphyra vulgaris* and *laciniata* are among the most valuable of our edible species. Under proper treatment, the marine sauce made from them, which in England and Scotland passes under the name of "laver," and in Ireland is called "sloke," can be rendered a grateful luxury. It requires many hours' stewing to render it sufficiently tender. Lightfoot mentions that the inhabitants of the Western Islands gather the weed in the month of March, and, after pounding and stewing it with a little water, eat it with pepper, vinegar, and butter; others stew it with leeks

or onions. In England it is generally pickled with salt, and preserved in jars; and when brought to table is stewed and eaten with lemon-juice.

Professor Harvey, in "Phycologia Britannica," says: "After many hours' boiling, the frond is reduced to a somewhat slimy pulp of a dark-brown colour, which is eaten with pepper, and lemon-juice or vinegar, and has an agreeable flavour to those who have conquered the repugnance to taste it, which its great ugliness induces; and many persons are very fond of it. It might become a valuable article of diet, in the absence of other vegetables, to the crews of our whaling vessels sailing in high latitudes, where every marine rock at half tide abundantly produces it. In its prepared state it may be preserved for an indefinite time in closed tin vessels."

But of all those used for food, *Gracilaria lichenoides*, an East-Indian species resembling our *G. compressa*, which, if as abundant, would be equally valuable, here deserves the first rank. This, under the names of "Ceylon Moss" and Agar-agar, is used in the East as a nutritive article of food, and for giving consistence to other dishes. It is of a very gelatinous nature, and when boiled down is almost wholly convertible into jelly, which is of a purer nature than that obtained from our *Chondri*. Large quantities are annually sold.

The famous edible birds' nests, so greedily swallowed by the Chinese, which sell for their weight in gold, were long supposed to be constructed from some species of *Gracilaria* or *Gigartina*: but it is now ascertained that the gelatine consists of an animal

substance, and is believed to be disgorged by the swallows that build the nests. *Sarcophycus potatorum*, one of the Fucaceæ, is said to be used as food by the natives of Australia; and Liballardière observed the natives of the woods round Van Diemen's Land use portions of its great leaves folded into the form of a pouch, for the purpose of keeping fresh water. Similar uses are assigned to *Durvillæa utilis* and other plants of the family, as applied by the people of the coast of Chili.

*Fucus esculentus* and *F. saccharinus* are plentiful in Norfolk Sound, and both of them are eaten, as is *F. edulis*, which is chiefly collected for winter store. In the bays of Conception and Valparaiso occurs plentifully the *Fucus antarcticus* (Chamisso), which has a round stipe extending to some feet in length, and of the equal diameter throughout of 1½ inch. The stipes and frond assume in drying the consistency of leather. This sea-weed forms a favourite article of food with the poorer classes of Chilenos, who prepare a savoury soup from it. The Kalosches eat the lower part of the stipe of the *Fucus vesiculosus*, both raw and cooked. I have tried it in the fresh state, but could perceive no peculiar flavour.

Some species of sea-weed have been applied in medicine. The mucus of *Fucus vesiculosus* and other species, was recommended by Dr. Russell, in diseases of the glands, for which iodine, exclusively obtained from plants of this family, and which probably exists in the mucus, is now considered so powerful a remedy.

It is a remarkable fact that the ancients derived almost all their remedies for diseases of the glands

from the sea; it deserves notice, for we may naturally suppose that their known virtues were the causes of their being almost universally used, especially as the practice of the ancients was not founded upon any particular hypothesis, but was rather derived from that mistress of all art, experience.

From these ancient times to the present, the juice of the sea-weed has maintained a certain degree of celebrity as a remedy in glandular diseases, and in general and local debility, at one time being highly extolled, and again sinking into neglect on account of the difficulties attending its use, but never entirely losing its good name, and still continuing to be used to some extent by the bathing-women and nurses at most watering-places.

Nor is it in this country alone that the sea-weed has maintained its ancient celebrity; for whilst, according to Dr. Neill, there is a common saying in Stronza, that he who eats of the dulse of Guerdie and drinks of the wells of Kildingie, will escape all maladies except black death, the inhabitants of the Alps, who are afflicted with goître, a disease consisting of an enlargement of the glands of the neck, chew the stem of a particular species, which they carry about with them, as a remedy. The Chinese and the inhabitants of Borneo manufacture from it several varieties of delicate food adapted for invalids; the North American Indians burn it to ashes, with which they cure swellings of the glands: and the Siamese have so great an esteem for it, that they mix it with their famous betel (*Areca*), which they are almost continually chewing.

In the year 1752, a very interesting work, written in Latin, was published by Dr. Richard Russell, entitled "A Dissertation on the Use of the Quercus Marina, or Sea Wrack, in Diseases of the Glands;" This well-known physician bestowed great pains and deep attention upon the subject, and was likewise eminently successful in his treatment of many diseases with this remedy, even under all the difficulties which he acknowledges to have attended its use.

The substance called Vegetable Ethiops, which has been used in glandular and scrofulous affections, is a kind of charcoal produced by the incineration of sea-wrack, or species of Fuci, in close vessels. The beneficial effects in such cases is principally due to the presence of a small quantity of iodine.

The stems of a sea-weed, *Sargassum bacciferum*, are sold in the shops, and chewed by the inhabitants of South America, wherever goître is prevalent, for the same purpose. This remedy is termed by them "Palo-coto" (literally goître-stick); and from the fragments I have seen, the plant is probably a species of *Laminaria.*

*Acanthophora muscoides*, and *Gracilaria* or *Plocaria Helminthocorton*, still hold a place in the Pharmacopœia as vermifuges, and are sold in the shops; but they have ceased to be in much esteem. As highly useful in some of the finer arts, I must not forget to mention *Gigartina tenax*, a Chinese species, which is extensively used by the ingenious inhabitants of that country as a glue and varnish. Large quantities of this plant, according to Turner as much as 27,000 lb. weight, are annually imported into Canton from the

provinces of Fokein and Tchi-kiang, and sold at from 6*d.* to 8*d.* per lb. It is converted by boiling into a vegetable glue of a very tenacious quality, which cools into a stiff jelly, and again liquefies on the application of heat. It is much used in the manufacture of the lanterns and transparencies for which the Chinese are so celebrated. Mr. Neill supposes that it forms a principal ingredient in the gummy matter, chinchou or hai-tsai, of China and Japan, with which "windows framed simply of slips of bamboo crossed diagonally, have their lozenge-shaped interstices wholly filled up." It is surely probable that when we become better acquainted with these plants, similar valuable properties may be discovered in other species of the genus *Gigartina*, and of the allied genera *Chondrus* and *Gelidium*, all of which may be converted into a gelatine by boiling.

Very large quantities of the yellow fucus, known as Agar-agar, were imported into Liverpool a few years ago from Singapore, and forwarded to the manufacturing districts, where its mucilage was used in dressing silks and other textile fabrics. Mr. T. C. Archer states that he has seen it brought to this country as a preserve, made by soaking it until it becomes much swollen, and then candying it in syrup. So transparent is it then that it cannot be distinguished from the syrup until it is taken out.

Agar-agar is the general Malay name for certain prepared algæ which have long been an article of commerce in the Eastern seas, and are extensively imported into China. When boiled with sugar, this sea-weed forms a sweet jelly, much resembling that made from

calves' feet, and is highly esteemed both by Europeans and natives for the delicacy of its flavour. Its cheapness and admirable qualities render it worthy of greater attention as an article of trade. The bamboo lattice-work for lanterns, in China, is covered with paper, which, when saturated with this gum, is similar to our paint. It is also used as a varnish, and as a size in the manufacture of silk and paper; and is preferable to flour for making paste, as insects avoid it.

The weed is found on the rocks at Pulto Ticoos and on the shores of the neighbouring islands. It is blanched in the sun for two days, or until it is quite white. It is also obtained on the submerged banks in the neighbourhood of Macassar, Celebes, by the Bajowlaut, or sea-gipsies, who send it to China.

A parasitical weed, the *Suhria vittata*, Agardh, has economical uses. It is common in Table Bay, particularly on the gigantic stems of the sea-trumpet, *Ecklonia buccinalis*. Like the carrageen, or Irish moss, the whole of this handsome sea-weed is soluble in boiling water, and transformed into a gelatinous mass. In the shape of jelly or blanc-mange it is advantageously employed in pulmonary complaints, scrofula, rickets, irritation of the bladder, &c., and as a demulcent and nutritive.

A particular species, supposed by some to be the *Fucus amylaceus*, thrown in great quantities upon the coast of Western Australia, is mentioned as forming, when boiled, sweetened, and spiced, a nutritious and beautiful jelly of a fine rose colour; and as it appears that it may be dried without injury, and preserved for years, it would be of value as an export. Perhaps

this may be the *Eucheumia;* for among the Western Australian products sent home to the Exhibition of 1862 were specimens of the *Eucheumia speciosum;* and 50 ounces of "jelly sea-weed," prepared from 63 lb. of the living weed, is capable of producing 100 quarts of fine blanc-mange.

The New Zealanders used to prepare a sea-weed jelly called Tutu, but, like many other articles formerly employed by the natives either as food or delicacies, it is now seldom or never seen. The preparation was, I am informed by Mr. Charles Hursthouse, chiefly confined to the natives along the northern shores of Cook's Straits.

The leaf of the large kelp, whenever it can be obtained by the aborigines of Van Diemen's Land and Australia, is greedily eaten after having undergone a process of roasting and maceration in fresh water, when, though tough, it is susceptible of mastication, and nutritious. A sea-weed found abundantly on Slopen Island, near Tasman's Peninsula, yields, by boiling, a very beautiful straw-coloured and nearly transparent jelly for the table.

Taking the *Laminaria saccharina* as a type of the membranous species of Algæ, Mr. Stanford found it to contain, besides mannite, 34 per cent. of a gum soluble in water, and much resembling dextrine. Boiled with a mixture of equal parts of nitric acid and water, this sea-weed furnished 22 per cent. of oxalic acid, in fine crystals, probably from the decomposition of the gum. By boiling this sea-weed with water, evaporating the solution, and treating the

residue with spirit, the mannite is dissolved out, leaving the gum, which may be of commercial value, either as it is, or as a substitute for sugar in making oxalic acid. The mannite may be crystallized from the spirituous solution.

The Carrageen, or Irish Moss of the shops, is a purplish white, nearly transparent sea-weed, furnished by *Chondrus crispus* and *C. mamillosus.* These afford demulcent and nutritive jellies, and of all algæ are the most used in England for food and medicine; the market supply is obtained from Clare and the west coast of Ireland. The *C. crispus* contains 79 per cent. of a peculiar gelatinous principle, called carrageenin; it differs from ordinary gum in not being precipitated by alcohol; from gelatine, by affording no reaction with tincture of galls; and from starch-jelly, by giving no blue colour with tincture of iodine. It is precipitated by alcohol, acetate of lead, and infusion of galls, and converted into grape sugar by boiling with dilute sulphuric acid. It contains $C_{12}$ $H_{10}$ $O_{10}$ according to Schmidt, and $C_{24}$ $H_{19}$ $O_{19}$ according to Mulder. It is employed in pulmonary complaints and in making bandoline, or fixature for the hair.

Carrageen is imported from Europe to the United States, blanched and freed from salt, and is kept on sale by most druggists. And yet it grows in such immeasurable abundance along the whole Atlantic coast of America, from Nova Scotia to Long Island, that it seems like bringing coals to Newcastle to import it there.

Carrageen is used for making jellies, for feeding cattle, for dressing the warp of webs in the loom, and for sizeing pulp in the paper-maker's vat. The collection and preparation of this sea-weed for market afforded a small revenue to the industrious peasantry of the west coast of Ireland, where these plants grow in great profusion. The price at one time was as high as 2*s.* 6*d.* per lb., but the demand has latterly diminished, and the price, of course, declined considerably, for it is now retailed in chemists' shops at 8*d.* per lb. The frond was boiled down to a gelatine, strained and used as a substitute for isinglass in the manufacture of blanc-manges and jellies, and was at one time a fashionable remedy in consumptive cases.

As the demand slackened for these purposes, it was tried as a size, and has been shipped to England for the use of calico-printers, but was not found to answer well for their purposes.

The jelly is far inferior to that made from Iceland moss, and it is alleged by the Irish peasants to disorder the bowels. It is now generally used in England and Ireland as food for live stock, being given to sheep, calves, and pigs. As an auxiliary in pig and cattle feeding the moss is boiled to a jelly. A quart of the jelly and two-thirds of the usual quantity of milk is given in each feed for the first week; the proportion of jelly is gradually increased to three quarts, and the milk withdrawn as the calf advances in age. In pig-feeding it is used with any other kind of food, such as potatoes, mangold-wurzel, turnips, or crushed grain.

A writer in *Household Words* speaks favourably of

it thus :—"I am not alone in my partiality for Irish moss. There was a time when it was a fashionable dish ; and it is still, everywhere in France and Great Britain, more or less prescribed as food for invalids. The poor of Brighton use it instead of arrowroot. The curly and mammal gristles are bleached like linen and cotton, and when dry will keep for years. An amiable and interesting writer—the late Dr. Landsborough—gives a recipe for cooking it, which is found to be excellent, from experience :—'When used, a tea-cupful of it is boiled in water; this water, being strained, is boiled with milk and sugar, and seasoning, such as nutmeg, cinnamon, or essence of lemon. It is then put into a shape in which it consolidates like blanc-mange, and, when eaten with cream, it is so good that many a sweet-lipped boy or girl would almost wish to be on the invalid list to get a share of it.'"

In the Bavarian breweries carrageen is used for clarifying the beer. Zimmerman, author of the "Beer Brewer" (Berlin, 1812), assumes the merit of having introduced it as a purifier; but I believe it had been previously used both in England and Ireland for this purpose. He says that 1 ounce of it is sufficient for 25 gallons of beer, and that it operates not only in the act of boiling with the hops, but in that of cooling, as also in the squares and backs before the fermentation has begun. Whenever this change, however, takes place, the commixture throws up the gluten and moss to the surface of the liquid in a black scum, which has to be skimmed off, so that the proper yeast may not be soiled with it. The

carrageen moss, as finings, is to be cut in fine shreds, thrown into the boiling thin wort, when the flocks begin to separate, and before adding the hops; after which the boiling is continued for an hour and a half or two hours, as need be. The clarifying with this kind of finings takes place in the cooler, so that a limpid wort may be drawn off into the fermenting "back."

A relative of my own, Captain George Parsons, of the ship *Ceres*, to whom I applied for what information his extended experience could supply on the uses of sea-weeds, thus replied to my inquiries:—

"My title to be heard upon sea-weed I establish thus:—My native place is near the sea-shore, before which, at some distance from land, an extensive shoal stretches, called 'Grund for tang,' which, being translated, signifies, 'Ground for sea-weed.' This shoal, I have heard, is in some places a regular submarine garden, and in winter, the north-east winds drive immense quantities of sea-weed ashore. Great heaps were often piled up on the beach, and some farmers used it extensively for manure, and many, very many pro and con. arguments have I listened to concerning its utility.

It seems natural that I should begin with its esculent properties first, for, if sea-weed is good food just as it is, I see no reason in the world in trying to convert it into wheat or barley: it should at once be handed to the cook. But I am decidedly of opinion that sea-weed is not very nutritious food, and I'll give my reasons. I know an old sailor in Shields, John R. by name, who from morning till night ate sea-weed whenever he could

get it. See old John when you would, he was chewing his weed ('dulse,' I think he called it). I've heard that John always kept a good stock on hand, and that he never went out without first filling his pockets. Still John never grew fat. The poor old man is now quite blind, and at times kind neighbours will remark, as he is led along by some of his grandchildren, 'Ah, why, he was always eatin them nasty sea-weeds, I'm sure that canna be good for niebody.' A few years ago I was at Limerick, and I recollect seeing a number of old women in the market selling sea-weed. Often these old bodies might be seen helping themselves to a bit of their ware. Perhaps they did this to encourage their customers, like the man in London that ate his own veal-pies, but they were all thin, meagre folks, quite the reverse of being in good condition. See one of them alongside of a tripe-woman, or a black-pudding vendor; why, the contrast would be striking.

"To come now to manure, were I writing for the benefit of farmers, I should only say: 'Get sea-weed for your land whenever you find it will pay you for the trouble and expense of getting it.' But I'm not writing for farmers. Well, I'll just state what I've seen people do with sea-weed, and how they did it. I was once at Crookhaven, and seeing a number of women scrambling about amongst the rocks, I went to examine what they were getting. It was sea-weed. Half-a-dozen dirty ragged women were cutting or tearing the weeds from the rocks, or dragging them out of small pools of water left by the tide, their implements for dragging being their bare hands. Each

had a basket, and when the basket was full it was lifted on-to the shoulders of one of the women. The rocks were sharp and rugged, and I stepped carefully lest I should damage my boots ; but the poor woman with the basket on her shoulders had no boots to damage ; her feet and legs were bare. Landwards she scrambled with her load, the slimy salt water trickling down her freckled neck, for her bristling hair, though luxuriant (no thanks to Rowland and Son), could not retain the whole of the moisture, and her tattered garments were saturated. I went the next day to see where they put it, and found that it was merely spread on the surface where potatoes had been planted.

" Another time I was in Loch Tarbot, Lewis Islands. Great improvements in farming have been made there, according to an old man's statements. Here is what he told me :—' Pefore, and its no sae lang syne either, folk didna ken muckle aboucht farmin, ye ken. Noo they'r aye better aff, they saw aits (sow oats) and noo folk can eat breed. Pefore mony time they couldna eat breed, and when they couldna eat fish either (of course, because they couldn't get them), they mony time had to gang to the sea-shore and peck limpets and the like shellfish, pefore they could eat. Noo, since they sawd aits, folk can aye eat breed.' I went to see his farm. The way they manage is this : they first burn the heather off the peat soil, then cover narrow strips of the land (about 6 to 8 feet broad) with a good layer of sea-weed. On each side of the weed-covered patches they dig a trench about two spades deep, throwing the peat soil on to the sea-weed, which

they cover with a layer of soil 6 to 8 inches thick. After the largest lumps are hacked a bit with a spade, the ground is ready for the seed, and they plant potatoes or ' saw aits,' as the case may be.

" In Jutland, many farmers cart sea-weed up to their farms and mix it with their other dung, leaving it to decompose. This is also done on the coasts of Durham. In Denmark it is often carted into great heaps, and when well decomposed, laid on the land by itself. Some use it fresh, but that is considered slovenly farming. All agriculturists, I believe, agree in the opinion, that sea-weed as a manure produces only a very transient effect. Some say it is good manure for one season, others that it is hardly worth a mile's cartage. Which opinion is right I shall not attempt to decide, but I think a great deal depends on the nature of the soil.

" Of all the uses I have seen sea-weed put to, that which pleased me the best, was an ornamental device I saw at Limerick. It consisted of sea-weeds of various colours, tastefully arranged in a wreath upon paste-board, in a frame. The ends were covered with needle-work, representing a small basket ; and underneath, in a lady-like style of penmanship, was written the following lines :—

"'The Plants of the Ocean thus set up their plea:
Oh ! call us no longer *the Weeds of the Sea ;*
Tho' we breathe not the odours of Earth's favour'd flowers,
Yet delicate forms and gay colours are ours.
The hand which adorn'd the sweet perfumed parterre
Did our fringe-like and fanciful dresses prepare.
As pendent we hang round the coralline caves,
Or float our light branches beneath the green waves ;

Or twine midst the gems of the watery deep,
Or climb up the rocks, or modestly creep;
Could you view all the beauties of which we might boast,
How varied our forms and our tints on each coast,
You would surely declare that the boon should be ours
Henceforth to assume the high title of Flowers.'"

Water-pitchers used to be made by the aborigines of Van Diemen's Land of the broad-leaved kelp. They were often large enough to hold a quart or two of water. These and a large sea-shell (a species of *Cymba*) were the only vessels they had for carrying water.

In the British Museum fishing-lines may be seen made wholly of a species of fucus, and others used on the north-west coast of America, made partly of sea-weed and partly of sinews. In the Kew Museum are also sea-weed trumpets, from the Pacific, formed of the stems of *Laminaria buccinalis*, Lamouroux. Dr. Henry Mertens, in Hooker's *Botanical Miscellany*, states that the Aleutians employ the stipes of a fucus, named by him *Fucus Lutheanus*, and known to the Russians as "sea-otter kohl," for fishing-lines. They are sometimes forty-five fathoms in length. He once saw the Kadiakensens in Sitcka make use of the cylinder as a syphon for pumping the water out of their Beidarkas, a use to which it is well known the *Ecklonia buccinalis* is often applied at the Cape of Good Hope.

Specimens of sea-weed used as rope in Vancouver, are shown at the International Exhibition.

Various attempts have been made to manufacture paper from sea-weed, but they have not been attended with any very great success. In 1820, a patent was granted in Denmark for making paper from sea-weed, said to be whiter, stronger, and cheaper than any

other paper. In 1828, a patent was taken out in the United States, by Elisha Collier, for making paper from *Ulva marina.* In 1833, a patent was granted in France, to Mons. Tripot, for making paper from sea-weed. On the 20th of June, 1855, a patent was provisionally registered by Messrs. G. Martinoli and O. De Lara for paper from sea-weed, and another in the same year to Charles Mabury Archer for his manufacture of paper and "the production of textile fabrics" from sea-weed, but neither of these patents were proceeded with.

The Chevalier Claussen states that, when he was experimenting on several plants for the purpose of discovering fibres for paper pulp, he accidentally treated some common sea-weeds with alkalies, and found they were entirely dissolved and formed a soapy compound which could be employed in the manufacture of soap. The making of soaps directly from sea-weeds must be more advantageous than burning them for the purpose of kelp, because the fucusoid and glutinous matter they contain are saved and converted into soap. The Brazilians use a malvaceous plant (*Sida*) for washing instead of soap, and the Chinese employ flour of beans in the scouring of their silk; and I have found that not alone sea-weed, but also many other glutinous plants and gluten, may be used in the manufacture of soap with advantage. If treated according to the process of Lord Dundonald's patent for obtaining gum from mosses, many of the sea-weeds would produce gum, but at a greater cost than either Turkey gum or dextrine at the present market price.

Pickering, in his "Voyage," tells us that, at Oahu, a green conferva is collected in the tide pools as an article of food, and on the reefs sea-weed (*Fuci*), but not indiscriminately, as one species was stated to be actually poisonous.

One of the culinary vegetables used on the Isthmus of Panama is the *Marathrum feniculaceum*, an edible plant resembling some of the finer sea-weeds, and which grows in most rivers of Veraguas. It is esteemed so highly by the inhabitants that they have called it Passe-carne, *i.e.*, excels or surpasses meat, and indeed the young leaf-stalks, when boiled, have a delicate flavour, not unlike that of French beans.

There is a fresh-water weed in China which is similar in nature and uses to our Irish moss. It differs from our sea-weed in being found on the banks of the celebrated fresh-water lake Yungting Hu, in the province of Huper.

For the manufacture of kelp and iodine, marine plants offer a large revenue to man.

Kelp is an impure carbonate of soda, mixed with the sulphate and muriate of the same alkali, and with some combinations of iodine and extraneous matter. It is prepared by merely burning the weeds, previously dried, in pits dug along the shore, till they are reduced to hard, dark-coloured cakes, in which state it is sent to market. On our shores the species used for this purpose are, *Fucus nodosus, vesiculosus* and *serratus, Himanthalia lorea, Laminaria digitata, bulbosa* and *saccharina*, and *Chorda filum*; but all the larger *Fucaceæ* are applicable. The crop is gathered

in the summer, dried and collected like hay, and towards the end of the season, burned.

Dr. Greville (introduction to "Algæ Britannicæ") has given us an interesting sketch of the origin and establishment of this branch of industry in the north of Scotland, where it was most extensively pursued until about the year 1817, when the removal of the salt duty made the manufacture unprofitable.

The manufacture of kelp was introduced into Scotland, according to Mr. Neill, half a century subsequent to its establishment in France and England, and the first cargo was exported from Orkney about the year 1721. The employment, however, being new to the inhabitants of Orkney, the country people opposed it with the utmost vehemence. Their ancestors never thought of making kelp, and it would appear that they themselves had no wish to render their posterity wiser in this matter. So violent and unanimous was the resistance that officers of justice were found necessary to protect the individuals employed in the work. Several trials were the consequence of these outrages. It was gravely pleaded in a court of law, on the part of the defendants, "that the suffocating smoke that issued from the kelp-kilns would sicken or kill every species of fish on the coast, or drive them into the ocean far beyond the reach of the fishermen, blast the corn and grass on their farms, introduce diseases of various kinds, and smite with barrenness their sheep, horses, and cattle, and even their own families." The proceedings exist in the records of the Sheriffs' Court,—a striking instance of

the prejudice, indolence, and superstition of the simple people of Orkney in those days.

The influential individuals who had taken up the matter succeeded in establishing the manufacture, and the benefits which accrued to the community soon wrought a change in the public feeling. The value of estates possessing a sea coast well stocked with sea-weed rose so much in value that, where the plants did not grow naturally, attempts were made, and not without success, to cultivate them by covering the sandy bays with large stones. By this method a crop of *Fuci* has been obtained, we are informed, in about three years, the sea appearing to abound everywhere with the necessary spores.

Upon the authority of Dr. Barry, during the years 1790 to 1800, the annual quantity made was 3,000 tons, and, as the price was then from £9 to £10, the manufacture brought into the place nearly £30,000 sterling in a season. During the eighty years subsequent to its introduction (from 1720 to 1800) the total value had risen to £595,000. These, (and during the war, when the price of kelp rose to £18 or £20 per ton), were the palmy days of the manufacture, but the demand has gradually slackened and the price fallen away. This result, so unfortunate for the owners of northern estates and the numerous population, in Orkney alone amounting to 20,000, who found a profitable employment in the manufacture, is to be attributed, at first, to the superior qualities of Spanish barilla, for the purposes of glass-making and soap boiling, but more recently to the removal of the duty on common salt, from the decom-

position of which soda is now so extensively manufactured as to supersede kelp almost entirely for the above purposes. In this ruinous state of the trade the kelp maker has had recourse to the agriculturist, and experiments have fully succeeded in showing the great value of kelp as a manure, whence an extensive demand may eventually arise; but it is not likely that the price can ever reach its former rate. But here again, soda obtained from rock salt comes into successful competition with it, so that the prospects of the unfortunate kelp grower seem hopelessly sunk, unless the demand for the purposes of extracting iodine be sufficiently remunerative to keep the trade alive.

In the proceedings of the Glasgow Philosophical Society there is an excellent article by Mr. Glassford on the manufacture of kelp. The rise in the price of kelp about the beginning of the present century caused the Highland proprietors to turn much of their attention to the manufacture. The supply could scarcely keep pace with the demand; the manufacture was pushed to the furthest limit, and for years continued to flourish. Barilla, however, from abroad entered the market and reduced the price of kelp materially. Barilla contained more soda and was preferred even at a higher price.

When the duty was taken off barilla and salt, kelp fell to less than £3 per ton, and the manufacture experienced a wonderful depression. As an instance, in the island of North Uist, the clear proceeds from kelp alone, in 1812, after deducting all expenses, was £14,000, and fell little short of that sum for several

years after; but the reduction of the duty on barilla brought down the return to £3,500. When M'Culloch visited the Hebrides in 1818, the total product of kelp from these islands was estimated at 6,000 tons, which, at £20 a ton, must have realized the sum of £120,000. At present there are scarcely 3,000 tons made, from which not above £6,000 are annually realized, after deducting the wages of the kelpers and the expense of the necessary apparatus. This small remuneration, however, is owing, in part, to the Highlanders' perseverance in manufacturing their kelp from the yellow wrack (*Fucus nodosus*) which, from growing in shallow water, and being less thoroughly a marine plant, yields much less iodine than the kelp made from the black wrack, such as *Laminaria digitata*, the great-stemmed tangle, and *Fucus serratus*, the serrated sea-weed. Irish kelp, prepared from drift-weed which has grown in deep water, is rich in iodine, yielding above 12 lb. per ton, and consequently, carefully and honestly prepared, Irish kelp brought, in some cases, £10 per ton in 1845, when Highland kelp would not bring above half of that sum.

The composition of kelp is very variable, not only as regards the proportion of carbonate of soda, but of the other constituents; hence the uncertainty which attended its employment in some of the chemical arts, particularly in the manufacture of crown glass.

The proportion of pure carbonate of soda varies from two to seven per cent.; the other constituents soluble in water are common salt, chloride of potassium, sulphate of soda, sulphuret of sodium, and traces of iodide of sodium. The insoluble matters,

which usually form about one-half the weight of the kelp, consist chiefly of carbonate of lime, alumina, silica, and sulphate of lime. The proportion of alkaline carbonate may be increased to some extent by conducting the incineration at a higher temperature than usual; but kelp is now valued more for its chloride of potassium and traces of iodine than for its alkaline carbonate, and a high temperature is attended with the loss of the iodide of sodium, in consequence of its volatility.

To separate the iodine and chloride of potassium the broken kelp is lixiviated with water, and the solution is evaporated in an open pan. When the solution is concentrated to a certain point, it begins to deposit, while boiling its common salt, carbonate of soda and sulphate of soda, which are removed in a perforated shovel, and the liquid is run into a shallow pan to cool, whence it deposits crystals of chloride of potassium. The mother liquor is subjected to a repetition of these operations to obtain more crystals; and the last mother liquor, which is a denser dark-coloured liquid containing nearly the whole of the iodide of sodium, is alone employed in the preparation of iodine. For this purpose it is merely heated in a peculiar distillatory apparatus with sulphuric acid and black oxide of manganese, or else with sulphuric acid only. A detailed account of this process is contained in Professor Graham's "Elements of Chemistry," p. 384.

The rise which, after twenty years of depression, took place in the price of kelp was owing to the great additional demand for iodine. Iodine is indispensable for the operator by the calotype and daguerreotype; and

the materials derived from kelp are of important use in the manufacture of soap, alum, green-bottle glass, &c.

The manufacture of kelp, or the burning of sea-weed to obtain its ash, was first carried on for the value of the carbonate of soda contained in it, but when the high war duties were taken off foreign barilla and salt, kelp, for which the demand had been very great, deteriorated in value and was scarcely worth making. The carbonate of soda is never now extracted from this source; the yield was always small, and it is now obtained so cheaply from common salt. In 1812, iodine was discovered by M. Courtois, manufacturer of saltpetre, in France. The discovery was announced by M. Desormes, at the meeting of the French Institute on the 19th November, 1813. The attention of the discoverer was first arrested by the destruction of his copper pans employed in the decomposition of nitrate of lime by the alkaline lye of the kelp. Having constantly observed this phenomenon, he attempted its solution, and after much patient research and many failures, he succeeded in tracing the effect to the cause and in preparing iodine in a state of purity. The manufacture of saltpetre having failed, Courtois took to the preparation of iodine as a source of profit, but in consequence of its then very limited application, the enterprise was unsuccessful, and the project was abandoned, but it was taken up afterwards by MM. Courneric, at Cherbourg, and there are still iodine works in that neighbourhood. Although, like many inventors, Courtois gained nothing by his discovery, a late distinguished English chemist turned it to good

account, and made a large sum of money by buying up all the mother liquors of the Scotch kelp works and extracting the new body. This element, iodine, has since been found widely diffused in nature. Kelp, however, is the only commercial source for its production, and the immense value of iodine, in photography and medicine particularly, has given an impulse to the manufacture of kelp, which renders it by far the most important of all the applications of sea-weed.

As at present carried on, it has many disadvantages; these are well known to chemists, but probably from the fact that it is conducted on desolate shores, at a considerable distance from centres of civilization, it has not yet received that attention its importance demands.

The manufacture is at present limited to a few parts of Great Britain, the western and northern islands of Scotland, the north-west coast of Ireland, and Guernsey.

In the Scotch islands the weeds are collected in the summer, dried in the sun, and burned in shallow rectangular pits; the fire requires a very high temperature, and the salt enters into igneous fusion; the fused mass is broken up by throwing water on it, and the kelp thus produced is a vitreous conglomerate, in the best specimens of which the carbonized stems of *Laminaria digitata* may be distinguished. It is of this plant—called bardarrig or the "drift weed"—that the most valuable kelp is made; if unadulterated it will yield the lixiviator from 10lb. to 15lb. of iodine per ton. The "cut-weed" is the *Laminaria saccharina*, called "Slaten-varra," but this is mixed

with several Fuci, and generally the latter predominate; the kelp produced from it does not afford more than half the iodine yielded by the former.

The kelp in the north-west of Ireland is made principally from the "drift weed" consisting of "sea rods," as the *Laminaria* is there called. It is burnt in small heaps, and at a lower temperature; the kelp produced is, consequently, more porous and much richer than that from the western islands. Some of the drift weed, too, is stacked in the winter for burning in the summer. A portion of the Irish kelp is made from "cut weed," principally the *Fuci*.

Professor Graham first directed attention to the sea-weed ash of Guernsey as the richest source of iodine; this results from the fact that the *Laminaria digitata* is used, and a very low heat is employed in the production of the ash. Mr. Arnold, of Guernsey, is the only lixiviator of kelp there, and he informs me that the local government more than once tried to stop the lixiviation altogether, and owing to the peculiar laws of that island he is unable to carry it to any great extent. A collection of his products was shown at the International Exhibition in 1862. A large manufactory in one of the Channel Islands could produce immense quantities of iodine and potash, and the insoluble ash would still be retained as manure.

I am indebted to Mr. William Paterson, of Glasgow, who alone lixiviates nearly four-fifths of the kelp of commerce, for the following statistics of the actual annual average amounts of kelp paid for, with the prices on the kelp shores. Those prices do not include

freight and other charges incidental to the carriage of kelp to Glasgow. The average is taken on the last two years :—

WESTERN ISLANDS.

| | | | | |
|---|---|---|---|---|
| 1,800 | tons cut weed kelp, | | @ £2 ........ | £3,600 |
| 800 | ,, drift weed | ,, | @ £4 ........ | 3,200 |
| 400 | ,, ,, | ,, | @ £6 ........ | 2,400 |
| 3,000 | | | | £9,200 |

ORKNEY AND SHETLAND ISLANDS.

| | | | | |
|---|---|---|---|---|
| 1,200 | tons drift weed kelp, | | @ £6 ...... | £7,200 |
| 150 | ,, cut weed | ,, | @ £2. 10s. .. | 375 |
| 1,350 | | | | £7,575 |

IRELAND.

| | | | | |
|---|---|---|---|---|
| 2,500 | tons drift weed kelp, | | @ £4 ...... | £10,000 |
| 500 | ,, ,, | ,, | @ £3. 10s... | 1,750 |
| 1,000 | ,, ,, | ,, | @ £5 ...... | 5,000 |
| 500 | ,, ,, | ,, | @ £6 ...... | 3,000 |
| 200 | ,, ,, | ,, | @ £6. 5s. .. | 1,250 |
| 80 | ,, ,, | ,, | @ £7 ...... | 560 |
| 1,300 | ,, cut weed | ,, | @ £2. 13s... | 3,445 |
| 6,080 | | | | £25,005 |

*Total Amount of Kelp, and Average Price, for the Years* 1860–61.

| | | | | |
|---|---|---|---|---|
| Scotland.. | 4,350 tons, | @ about £3. 17s., | valued at | £16,775 |
| Ireland .. | 6,080 ,, | ,, £4. 2s., | ,, | £25,005 |
| | 10,430 | | | £41,780 |

In round numbers, the average yield of British kelp may be taken at 10,000 tons, giving, at £4 per ton, an annual income of £40,000.

This quantity of kelp represents about 200,000 tons of wet weed, an amount which, large as it seems, is

insignificant compared to the immense masses of sea-weed annually deposited on the coasts of Great Britain and Ireland. The best drift weeds appear to be torn up from the Atlantic, as they are found chiefly on the western coasts in Guernsey and Jersey. The best are taken from the bays on the west coast; and the poorer sample of vraie I alluded to as having seen in a cottage at Jersey, was collected in St. Catherine's Bay, on the east coast. The "cut weed" is the same all round the islands. A great deal of drift weed, however, finds its way up the Channel, and is washed in and out of the numerous harbours and thrown on the flat coasts; this is particularly the case in Brading Haven, in the Isle of Wight, where it is carried in and out in large quantities. Many thousands of tons of sea-weed of various kinds are deposited annually on the coasts of Sussex, but a small portion of which is utilized. Kelp is also still manufactured on the coast of Normandy, in France: the weeds obtained are very similar to those of the Channel Islands. MM. Tissier, aîné et fils, of Finisterre, are the principal manufacturers of iodine and potash. A large quantity of iodine is, however, imported from England into France.*

M. F. B. Tissier has been enabled to reduce to 40f., 30f., 20f., and 15f. the kilogramme (according to the quality and degree of purity and concentration of the iodine) a product which the manufacturers sold, in 1811, at 600f., and which is taken in all the principal markets of the world.

* Mr. Stanford in Soc. of Arts Journal.

In 1825 M. Tissier was engaged with success in the manufacture, at Cherbourg, of iodine and iodide of potassium. In 1830 he associated with him M. Guilham, and established, at Bonquet, in Bretagne, a manufactory, which has been continuously worked, and which became his exclusive property in 1845. Since that period he has largely extended his operations, resulting in great benefit to the poorer classes of the coast population.

In 1855 he stated to the International Jury at Paris, which awarded him a first-class medal, that he employed 1,100 workmen, who received annually among them a sum of 200,000f., and produced, without any great effort, 1,500,000 or 2,000,000 kilogrammes of crude soda. From this quantity M. Tissier has supplied not less than 250,000 kilogrammes of impure chloride of sodium for the use of the glass-works, and as a flux in the potteries 200,000 kilogrammes of chloride of potassium at 92 per cent., sold to the manufacturers of saltpetre and alum.

MM. Tissier have furnished me with valuable statistical information on the kelp manufacture in France. Their statements will astonish those who consider England to be in advance in this branch of industry; their position among the first and largest lixiviators of kelp, and their well-known name, are ample guarantees of their ability to judge and to speak practically of this question. They estimate the total annual production of kelp (soude brute) in France at 25,000,000 kilogrammes; this is about 24,000 tons, or more than double the yield of the kelp shores of Great Britain. MM. Tissier alone, in their Usine de Con-

quet, work annually 4,000,000 to 5,000,000 kilogrammes. They have favoured me with the following interesting table of the products annually extracted from this source by the seven principal factories in France :—

| USINES. | Iode et Iodure de Potassium. | Brome et Bromure de Potassium. | Chlorure de Sodium. | Chlorure de Potassium. | Sulphate de Potasse. | Nitrate de Potasse. |
|---|---|---|---|---|---|---|
| | Kilos. | Kilos. | Kilos. | Kilos. | Kilos. | Kilos. |
| Le Conquet.. | 20,000 | 1,500 | 800,000 | 500,000 | 200,000 | 200,000 |
| Granville.... | 20,000 | 800 | 800,000 | .. | .. | 1,000,000 |
| Cherbourg .. | 5,000 | .. | 200,000 | 180,000 | 80,000 | .. |
| Montsarac .. | 4,500 | .. | 180,000 | 150,000 | 75,000 | .. |
| Pont-l'Abbé . | 4,000 | 200 | 150,000 | 140,000 | 70,000 | .. |
| Portsall .... | 4,000 | .. | 150,000 | 140,000 | 65,000 | .. |
| Quatrevents.. | 2,500 | .. | 100,000 | 90,000 | 50,000 | .. |
| | 60,000 | 2,500 | 2,380,000 | 1,200,000 | 540,000 | 1,200,000 |

The lixiviation of British kelp is almost confined to Glasgow, where there are now six principal lixiviators : of these, Mr. W. Paterson is by far the largest ; he works from 7,500 to 8,000 tons per annum. His enormous factory is well worth a visit, and I am glad of an opportunity of acknowledging his attention and courtesy in showing me over it. The process usually followed is sufficiently simple ; the kelp is lixiviated with water, and the solution evaporated ; the sulphate of potash deposits first in small crystals, and then the chloride of sodium ; these are separately collected, and the solution is then run off into iron coolers, where a crop of crystals of chloride of potassium is deposited in three or four days. This process is repeated with

the mother liquor; and after the second crop of chloride of potassium has crystallized out, the mother liquor is very dark, and contains sulphides; oil of vitriol is added to decompose these, and much sulphur is precipitated; this is one of the bye products of the factory. The liquor, after the addition of the oil of vitriol, is decanted from the deposited sulphur, and distilled with binoxide of manganese in leaden retorts; the iodine sublimes, and is received in earthen vessels.

This process is simple and effective, and I can suggest no improvement; but its success is entirely dependent on the preparation of the kelp employed, and it is in the primary treatment of the sea-weeds that reform is so much needed.

Mr. Paterson, who may be considered the highest authority on this question, states the present yield of iodine from good drift-weed kelp to vary from 8 to 14 lb., but the low quality of drift-weed kelp produced in the islands of North and South Uist and the county of Donegal does not yield more than from 4 to 6 lb. per ton of $22\frac{1}{2}$ cwt. He accounts for the bad quality of the kelp of Uist by the large admixture of sand from the shores of those islands. It is probably also much mixed with inferior sea-weeds. The statement of the amount of iodine from the *Laminaria digitata* is the average of three estimations; and to show the amount that ought to be obtained from this species, I may state that this corresponds to 32 lb. of iodine per ton of kelp. Many of the analyses of sea-weeds hitherto published have been performed on different kelps; and

as these always contain the ash of several species, little dependence can be placed on them as an index of the relative composition of each species. The plants here experimented on were carefully selected. The amount of iodine will be seen to be exceedingly small in the *Fucus vesiculosus*, and kelp made from that sea-weed alone would be valueless. It would yield only ·99 lb. per ton; but practically it always contains the ashes of others sufficient to bring it up to about 4 lb. per ton. Sarphati estimated the iodine in this species to be ·001 per cent.

I would call attention to the large yield of potash from that very common weed, *Rhodomela pinastroides*. The soluble ash it yields is very variable in quantity, the fronds being always more or less covered with zoophytes, which largely increase the amount of ash without adding to the soluble portion. The results given are the mean of three analyses.

Many have been struck by the peculiar odour evolved in burning sea-weed; this, at the outset of these experiments, arrested my attention, and led me to examine the products evolved in combustion. These were in all cases the same, differing only in quantity:—

An inflammable gas;

Water, containing carbonate and acetate of ammonia, and a kind of naphtha;

A fluid tar, containing a volatile oil, some of which also floated on the water.

A light charcoal remained in the retort; this was lixiviated with water, and treated as ordinary kelp;

the solutions obtained were colourless, and the salts perfectly white and pure. The mother liquor formed a striking contrast to those usually seen ; it was nearly colourless, and contained mere traces of sulphur compounds ; the amount of iodine yielded was unusually large.

The products of distillation were then examined. The gas burnt exceedingly well, giving a flame of little luminosity at first, but becoming very luminous towards the end of the distillation. A portion collected at first gave 41·66 per cent. of carbonic acid. Another portion, collected towards the end of the distillation, gave only 13·3 per cent. of carbonic acid, and contained olefiant gas. The gas given off in the distillation of wet weed is also inflammable, but the flame is occasionally extinguished by the vapour of water thus simultaneously generated. A portion of this gas gave 50·84 per cent. of carbonic acid.

The condensed liquid was very alkaline ; it yielded ammonia in abundance on distillation with lime. The ammonia appears to exist in the liquid as bicarbonate ; crystals of this salt were found in some of the gas tubes. The chloride of ammonium in the crude state prepared by neutralising this with hydrochloric acid has an odour of picoline, an alkaloid which is also found in the volatile oil. The naphtha distilled from this liquid burns with a slightly luminous flame. Rectified over lime, its specific gravity is ·826 ; this commences to boil at 155°. It is not a simple substance, but appears to be a mixture of acetone and methylic spirit. By repeated rectification I have succeeded in reducing the boiling point of the first por-

tion below 140° Fah., but I have been unable to effect any definite separation of it, either by treatment with chloride of calcium or by repeated fractional distillation.

The residuum in the still, after the distillation of the ammonia and naphtha, was found to be a solution of acetate of lime; distilled with hydrochloric acid, this furnished acetic acid, the last portions of which contained also butyric acid.

On the tar being distilled with water, a volatile oil of very peculiar odour was obtained; this odour resembling that of burning sea-weed. In the crude state it contains about 1·2 per cent. of the naphtha, and about 1·6 per cent. of a body analogous to kreosote. Diluted hydrochloric acid removes from it about 3·7 per cent. of a mixture of volatile alkaloids containing picoline, &c., and a red pitchy colouring matter is separated. It also contains pyrrol. After purification with oil of vitriol and caustic soda, the oil presents the appearance and properties of a mixture of pure hydrocarbons analogous to those from coal-tar naphtha. Its specific gravity is 841, and its boiling point rises from about 180° to above 400° Fahr. The oil here treated of is a pure hydrocarbon, and has not been hitherto obtained from this source. It will be applicable to many of the uses for which coal-tar naphtha is so much in demand. The colouring matter separated from the oil by an acid is a product of decomposition. It is soluble in oil of vitriol, gacial acetic acid, alcohol, and methylic spirit. It is insoluble in water, either cold or boiling, and separated from all its solutions by its addition; it is also insoluble in chloroform, ether, benzole, bisulphide of

carbon, oil of turpentine, the fixed oils, and dilute acids. It is unaffected by boiling hydrochloric acid. Nitric acid has no effect on it in the cold, but decomposes it when boiling, forming oxalic acid. Boiling oil of vitriol carbonizes it. It is decolourised by chlorine. The caustic alkalies partially decolourise, but do not dissolve it; the colour is restored by an acid. It is, however, chiefly remarkable in containing iodine, and it holds it in such close combination that boiling solution of potash does not remove it, and it is only when fused with hydrate of potash that it can be detected. It is thus converted into oxalate of potash and iodide of potassium; it was found to contain 35 per cent. of iodine. I do not anticipate that it will be valuable as a dye, as it shows a tendency to fade. In a chemical point of view, I look forward with interest to its thorough examination when I shall have obtained it in sufficient quantity; the greater the heat employed in distilling the weed, the more of this substance is produced. The tar, after the volatile oil had been removed, presented the appearance of Stockholm tar, which it might well replace; it was then distilled alone, and a fixed oil was separated; this contains on an average 5·2 per cent. of a crude acid analogous to kreosote. The oil, after this has been removed by potash, is purified with oil of vitriol, and it then resembles the paraffin oil of commerce. It will thus be seen that all these products are of considerable commercial value, and it remains now to show what are the quantities yielded. The same species were experimented on for this purpose: the weeds were compressed into cakes, and distilled in a small iron

gas retort. The quantitative results are shown in the following tables.

The tar is that left after distilling in the presence of water.

The following table shows the comparison of sea-weed with peat in the products of destructive distillation. Peat is worked with profit in the Hebrides, and largely on the continent, for these alone; the ash is valueless. The peat results in the table are taken from valuations by Sir R. Kane and Mr. Sullivan, for the Irish Peat Company. It will be seen that in the products of distillation alone, the advantage is considerably on the side of the sea-weed, while the lixiviation of the sea-weed ash is already a lucrative manufacture, and its value will by this process of distillation be much increased.

PRODUCTS *obtained in the Destructive Distillation of Dry Sea-weeds, compared with those at present obtained in the Destructive Distillation of Peat.*

| | AVERAGE YIELD OF SEA-WEED. Present Kelp-bearing Species.* | | AVERAGE YIELD OF PEAT. By Sir R. Kane and Mr. Sullivan. | |
|---|---|---|---|---|
| | Per Ton. | Per 100 Tons. | Per Ton. | Per 100 Tons. |
| Volatile oil | 289·3 oz. | 181 galls. | 320 oz. | 200 galls. |
| Paraffin oil | 360·4 oz. | 225 galls. | 157·7 oz. | 98·6 galls. |
| Naphtha | 162 oz. | 102 galls. | 66·3 oz. | 42 galls. |
| Sulphate of ammonia | 70·9 lb. | 3 tons 3 cwt. 34 lb. | 22·4 lb. | 1 ton. |
| Acetate of lime | 10·5 lb. | 9 cwt. 42 lb. | 6·8 lb. | 6 cwt. 8 lb. |
| Pure charcoal | 3 cwt. 49½ lb. | 17 tons 4 cwt. 22 lb. | 4 cwt. 103 lb. | 21 tons 11 cwt. 108 lb. |
| Gas (approximative) | 1,161 c. feet. | 116,100 c. feet. | 1,475 c. feet. | 147,500 c. feet. |
| Colouring matter | 1·85 lb. | 1 cwt. 73 lb. | .. | .. |
| Chloride of potassium | 1 cwt. 63 lb. | 7 tons 16 cwt. 28 lb. | .. | .. |
| Chloride of sodium | 1 cwt. 79½ lb. | 8 tons 10 cwt. 110 lb. | Valueless. | Valueless. |
| Insoluble ash | 1 cwt. 54½ lb. | 6 tons 10 cwt. 90 lb. | 103 lb. | 4 tons 11 cwt. 108 lb. |
| Iodine | 3·26 lb. | 326 lb. | .. | .. |
| Paraffin | Not estimated. | Not estimated. | 3 lb. | 300 lb. |

* Laminaria digitata, L. saccharina, Fucus vesiculosus, F. serratus, and F. nodosus.

## PRODUCTS *from a Ton of Kelp.*

NOW OBTAINED.

| SPECIES. | Laminaria digitata. | Laminaria saccharina. | Fucus vesiculosus. | Fucus serratus. | Fucus nodosus. | Average. |
|---|---|---|---|---|---|---|
| | cwt. lb. | cwt. lb. | cwt. lb. | cwt. lb. | cwt. lb. | cwt. lb. |
| Chloride potassium .. | 6 56 | 8 20 | 2 72 | 4 96 | 4 46 | 5 35 |
| Chloride sodium ...... | 6 45 | 5 53 | 6 78 | 5 24 | 7 41 | 6 25 |
| Insoluble ash ........ | 3 89 | 3 103 | 4 63 | 6 38 | 5 53 | 4 92 |
| Iodine .............. | 0 12·77 | .. | .. | .. | .. | 0 5 |
| ADDED BY MR. STANFORD'S NEW PROCESS. | | | | | | |
| Volatile oil .......... | 4¾ galls. | 4½ galls. | 9⅔ galls. | 6½ galls. | not estimated. | 6¼ galls. |
| Paraffin oil .......... | 4¾ galls. | 5⅙ galls. | 13⅙ galls. | 7⅓ galls. | 14⅓ galls. | 9 galls. |
| Naphtha ............ | 3 galls. | 2⅔ galls. | 5⅔ galls. | 2½ galls. | not estimated. | 3½ galls. |
| Sulphate of ammonia.. | 1 cwt. 46 lb. | 2 cwt. 17¼ lb. | 2 cwt. 32½ lb. | 2 cwt. 38½ lb. | 3 cwt. 108½ lb. | 2 cwt. 48 lb. |
| Acetate of lime ...... | 17½ lb. | 21 lb. | 75 lb. | 36⅔ lb. | not estimated. | 37 lb. |
| Colouring matter .... | 2¾ lb. | 5¾ lb. | 11½ lb. | 6 lb. | | 6½ lb. |
| Pure charcoal ........ | 8 cwt. 35½ lb. | 8 cwt. 59 lb. | 15 cwt. 10 lb. | 14 cwt. 41 lb. | 20 cwt. 49 lb. | 13 cwt. 39 lb. |
| Gas (approx.) ........ | 3,615 c. feet. | 2,771 c. feet. | 4,313 c. feet. | 3,811 c. feet. | 8,272 c. feet. | 4,456 c. feet. |
| Iodine .............. | 19·39 lb. | .. | .. | .. | .. | 5 lb. |

These analyses conclusively prove that the present method of manufacturing kelp is an exceedingly wasteful one; for not only are the constituents of the ash largely dissipated, but these valuable products of distillation are all volatilized into the air; and taking, as a rough calculation, 10,000 to be the annual yield of kelp, we have the following quantities annually disposed of in this manner :—

| | |
|---|---|
| Volatile oil .. .. .. | 62,500 galls. |
| Fixed oil .. .. .. | 90,000 ,, |
| Naphtha .. .. .. | 34,000 ,, |
| Ammonia :— | |
| (Calculated as sulphate) .. | 1,216 tons. |
| Acetic acid :— | |
| (Calculated as acetate of lime) | 167 ,, |
| Pure carbon .. .. .. | 6,674 ,, |
| Colouring matter .. .. | 29 ,, |
| Gas .. .. .. | 45,560,000 cubic ft. |
| Iodine .. .. .. | 50,000 lb. |

I leave commercial men to affix the values to these products, and then weigh the amount against the £40,000 at present paid for the residuum of this waste. Can we wonder that the kelper works in rags? Can we be surprised that his operations are confined to desolate sea shores? Or is it astonishing that the kelp districts bring little revenue to their proprietors—that the tenants pay little or no rent, when they thus throw half their harvest away? It is difficult for those who have not visited these coasts to form an idea of the vast accumulations of sea-weed thrown up in the winter, yet these, universally admitted to be the most valuable, are all lost. Is it possible that the utilitarian spirit of this age will

permit this enormous waste to continue? Unless the lairds of the kelp districts take the subject up themselves it will still be so, for they cannot expect their poor tenants to erect works for this purpose, as the lion's share of the advantage must ultimately fall to their own lot. With the view of interesting them in the subject I beg to call attention to the following proposed improvements:—

1. Sea-weeds of all kinds are to be stored under cover; they should be first collected in heaps, to drain off the superficial water, and then laid out in drying sheds; in summer, advantage may be taken of the sun's rays. Sea-weeds, when laid out thin, are not so difficult to dry as is generally supposed, and when dry keep perfectly well under cover.

2. The sea-weeds thus dried are then to be compressed into cakes, by hydraulic or other pressure; this is not essential, but the cakes occupy less room in stowage, and if the charcoal obtained is to be used for fuel, this treatment improves it.

3. The cakes, or the unpressed weed, are then to be distilled at a low red heat, in iron retorts; the tar and aqueous products to be collected in suitable condensers, and the gas in a gasometer. The gas may be employed for heating the stills used for rectifying the products, for heating the drying sheds, or even for lighting the factory; it might even be treated according to Pettenkofer's method of superheating, and used as a means of lighting a district.

4. The charcoal is to be lixiviated and treated as ordinary kelp, and then thrown out in heaps to dry in the air. When raked from the retorts it should be

allowed to fall into the lixiviating water, or into iron boxes, to protect it from the air; if the latter plan be adopted the heat may be rendered available for drying the weeds by wheeling them into the drying shed. The lixiviation will require larger tanks for its conduction than those at present employed, on account of the greater bulk of the charcoal; it has the advantage, however, of floating on water, and as the charcoal, when saturated, sinks to the bottom, it is quickly replaced by a fresh portion, and the solution is thus rapidly effected. The solution should be roughly evaporated to dryness, and the salt thus obtained sold to the lixiviator.

5. The washed and air-dried charcoal is to be used for heating the retorts and evaporating the solutions of the salts. Should, however, peat be very abundant in the neighbourhood, this charcoal may be manufactured into manure, by treating it with the ammoniacal liquid; or be applied to some of the many uses for charcoal, and the peat employed as the fuel. The ash from the charcoal is a valuable manure; it usually contains over 20 per cent. of earthy phosphates. The phosphates of magnesia predominate, and these are partially soluble in water. The proportion of phosphate is about that in Peruvian guano, and if the crude ammoniacal salt obtained by distillation were added in the proportion of about 40 per cent., a manure would be obtained worth from £10 to £12 per ton, of which from 3 cwt. to 4 cwt. would be sufficient for an acre of land. The phosphate of magnesia it contains points to its special application to beet-root and clover. Mixed with about 5 per cent.

of the chlorides of potassium and sodium, it would be equally beneficial to other root and cereal crops. Liebig divides crops, according to their wants, into three classes—potash plants, lime plants, and silica plants; such a manure contains the food for all or either of these.

6. The products of distillation I recommend to be treated as follows:—The tar is syphoned off, and distilled with an equal measure of water in an iron tar still; the light volatile oil passes over with the condensed water, on which it floats. This is decanted, and treated with dilute sulphuric acid, which removes picoline and other oily bases, and the red colouring matter is deposited. This substance is washed and dissolved in spirit, and the solution deposits it on evaporation. The light oil is then agitated with from 5 to 10 per cent. of oil of vitriol, washed with water and caustic soda, and finally re-distilled. The residual tar, from which the light oil has been removed, is then pumped into another iron still, and a stronger heat applied. The paraffin oil is thus obtained, and purified by oil of vitriol, caustic soda, and re-distillation. The residual pitch may be employed for the manufacture of patent fuel, &c., or pumped while hot into brick ovens provided with an iron pipe to carry off the heavy vapours, and subjected to a red heat, by which a further portion of paraffin oil is obtained, and a good coke left in the still, commercially valuable to ironfounders, on account of its freedom from sulphur. The liquid in the condensers, being separated from the tar, which sinks to the bottom, is mixed with excess of lime, and distilled in a capacious iron still provided

with a suitable condenser. Ammonia and naphtha pass over, and are received into hydrochloric acid. The solution of acetate of lime remaining in the still is run out, evaporated to dryness, and the black, impure acetate thus obtained purified by charring, re-crystallization, distillation, or conversion into acetate of soda. The ammoniacal distillate which has been neutralised by hydrochloric acid is re-distilled till the specific gravity of the distillate rises nearly to that of water. This is best distilled by the agency of steam. The first portion which comes over is the naphtha; this is collected separately, the weaker liquor subsequently distilled being returned to the still with the next charge. Re-distillation over quick lime yields it in a state of purity. The solution of chloride of ammonium remaining in the still is run out, evaporated, crystallised, and the crystals sublimed according to the ordinary method of making the sal-ammoniac of commerce.

This process offers the following advantages:—

1. Retention of the whole of the iodine.

2. Easy and rapid lixiviation, colourless solutions and pure salts.

3. Absence of sulphur compounds in the mother liquor, great saving of oil of vitriol, and no evolution of poisonous gases.

4. Factory, to a great extent, self-supporting, having its own means of heat and light, the fuel being extracted from the weed itself.

5. Manufacture continuous, affording employment to the kelpers all the year round, and at a higher rate of remuneration.

6. Extension of the manufacture, as this process

allows a much larger margin for profit, and admits of the lucrative working of the commonest weeds, which will not, I anticipate, be allowed to rot on the shores of Great Britain when their commercial value becomes known.

There are many sea-weeds which contain little iodine, but are well worth working for potash; thus grass wrack contain 15 per cent. in the ash, and *Rhodomela pinastroides* 16 per cent., and these have never been worked. The extraction of chloride of potassium from sea-weed is not sufficiently thought of, as it is now one of our principal sources of saltpetre, on which so much depends in time of war; this is now made very largely by the decomposition of nitrate of soda by chloride of potassium. Considering, then, the great value of sea-weeds as a source of potash, and the only available source for that very valuable element iodine, it is not a question as to whether they should or should not be worked, but it is an absolute commercial necessity that the iodine and potash should be extracted from them; and the question is, what is the best method of doing it?

It is a remarkable fact that the principal commercial sources of ammonia are carbonised plants, in the shape of coal; and that these plants were mostly cryptogamic, and very near the algæ in the botanical scale; the present century has developed a source of unbounded national wealth in the former, and I believe that a great future is open to the latter. We reckon a country's riches not so much by its gold and silver as by the coal it is enabled to produce and consume: and although we do not now believe in the transmuta-

tion of metals, and we have desisted from our ancestors' fruitless searches for the philosopher's stone, the spirit of alchemy is still amongst us, and it presides over the extraction of valuable products from cheap and apparently useless materials. Sea-weeds have been regarded in the latter class, and these researches will, I hope, be the means of directing attention to their intrinsic value.

Mr. Stanford's process has been patented in England and France; and if he is not too sanguine in his expectations, a great reform will be introduced into, and a largely increased income will be derived from, the kelp-bearing districts of Scotland and Ireland, the social state of their inhabitants will be greatly ameliorated; and even in wealthy England, "Algæ inutilis est," will be no longer a proverb.

Mr. W. L. Scott, writing on Mr. Stanford's paper, says: "It is indeed remarkable that a raw material, presented to us in such vast quantities, should, up to the present date, have been allowed to remain without use or application, while the 'utilisation of waste products' forms so prominent a feature in the arts and manufactures of the age. Great Britain alone, irrespective of Ireland and the Scottish Isles, possesses a sea-coast line of about seven thousand miles in length, from which I have reason to believe that sea-weed could be collected to any amount, up to an average of 3,000 tons per mile per annum, or rather more.

"Of this vast and tolerably regular natural supply, what a minute proportion is now collected. Even in its most prosperous days, kelp was never manufactured to a greater extent than 28,000 tons per annum, as far as

I can learn. The applications of algæ as food and medicine are, as Mr. Stanford truly observes, exceedingly limited, but I am of opinion that these might soon be very considerably extended if the inquiry were entered upon in a really systematic and practical manner.

"Several of the gelatinous varieties would doubtless become very palatable if boiled or macerated for a sufficient length of time in water or syrup (in the same way that the Chinese preserved ginger is prepared), or if converted into 'candy.' I have myself tasted some varieties of *Dictyota* and *Punctaria* thus prepared, which were by no means unpalatable.

"With the mucilaginous substance obtained from the *Gelidium corneum*, and other sea-weeds, I have prepared paper for photographic purposes, giving pleasing 'tones' and very durable pictures.*

"I have often regretted that the manna of commerce should remain so costly for the poorer classes, as, if more reasonable in price, it would be greatly in demand as a mild and simple purgative, especially adapted for children and many adults of delicate constitution. Now the retail price of this manna (which varies greatly in quality) is about 6d. to 10d. per ounce, according to the conscience of the druggist selling the same, while the same substance, or, more correctly, its active principle, mannite, might easily be sold for about 1½d. per ounce, if prepared in large quantity from sea-weed. Some years back I extracted some

* Paper and pulp from sea-weed were shown in the Belgian court of the Exhibition, 1862.

pounds from the *Laminaria* (various species), and placed a portion in the hands of a provincial druggist, under the title of 'prepared manna.' It soon 'gave great satisfaction' to the customers, and the druggist offered to purchase the article at a higher rate than he paid for the foreign manna. I need hardly say that the transaction, being 'out of my line,' was 'declined with thanks.' In some specimens of *Laminaria* I have found as much as 17·5 per cent. of mannite.

"As regards the destructive distillation of sea-weeds, a wide and useful field of research is open to us, as the kind and quality of the products obtained always vary with the temperature employed, a fact, I think, not mentioned by Mr. Stanford.

"Although the natural colours of many sea-weeds are extremely beautiful—especially among the *Rhodosperms*—I do not think many attempts have been made to extract the colouring matters of these for dyeing purposes. Several varieties of *Griffithsia* yield a brilliant crimson colour to pure water, which is precipitated again on the addition of certain soluble chlorides. This substance (which might be very appropriately called *Rubalgine*) appears to combine with alumina and other metallic oxides. Again, on many shores may be observed masses of a fine yellowish-brown algæ, which, after a few hours' exposure to the sun's rays, change to a deep red hue; surely a chemist may take the hint here thrown out. The colour may generally be developed from these 'weeds' (*Plocamium*) artificially under the influence of an oxidizing agent, such as nitric acid or formiate of potassa.

"In the ash of *Rhodomela subfusca* I have deter-

mined as much as 19 per cent. of potash, a higher proportion, I think, than Mr. Stanford has met with."

The chief source of iodine is still found in the *Fuci*, and so long as this remains the case, a certain demand for kelp, from which that valuable substance is most easily extracted, may be maintained. Many of the species that produce kelp are useful in minor ways. My friend, Dr. Pappe, in his "Floræ Capensis Medicæ," states, "Our (S. African) shores are well strewed with algæ, and amongst them are found species distinguished both for extraordinary piquancy and gigantic size. It is certain that the *Ecklonia buccinalis*, Hornm. (*Zee-bamboes*, of the Dutch); our *Sargassa*, *Laminariæ*, and *Iridaeæ*; the *Macrocystis planicaulis*, Agardh; the *Desimarestia herbacea*, Lamour; and many more of our large marine plants, would easily yield a vast quantity of iodine, if the experiment of preparing it were thought worth a due trial."

One of the most recent applications of sea-weed is contained in a patent dated the 4th October, 1861, taken out by Mr. Thomas G. Ghislin, formerly of the Cape colony, who proposes to apply it to various useful purposes for which horn, shell, whalebone, indurated leather, fish-skin, ivory, bone, hard woods, and compounds of India-rubber or gutta-percha have hitherto been employed. From his specification I make the following extracts:—

"This invention relates to improvements in the treatment or preparation of certain plants or marine substances, and the application of such plants or substances to various manufacturing purposes.

"The plants or substances I use for the purposes of

my invention, are those known to botanists as the *Ecklonia buccinalis*, *Laminaria buccinalis*, *Durvillæa utilis*, *Sarcophycus potatorum*, and their allies.

"I propose to apply the above-named substances to the following uses, viz., veneering, coating, mounting, and inlaying applied to wood, metal, glass, papier mâché, or any other material. To the manufacture of handles for cutlery, surgical instruments and tools, whips, umbrellas, and parasols; to the manufacture of walking-sticks, and acoustic and musical instruments, picture and other frames, medallions, book-covers, and a variety of miscellaneous articles.

"In preparing the raw material for the purpose of my invention, I cut off or remove all extraneous matters, and then immerse the substance in a hot lye of caustic lime for about three hours, and on removing it from the lime it should be steeped in a bath of sulphuric acid, diluted with about fifty times its weight of water.

"The substance may then be removed from the acid and placed in a solution of common soda. After which, any mucilage or dirt that may adhere externally to the plant should be brushed away; and after washing it for a time in pure water, the prepared substance may be removed to the drying-room, and when half dry, it can be shaped into any form desired. By opening out the tubular plant, and laying it flat to dry under pressure, it will be converted into sheets.

"As a modification of the process just described, the plant, after being trimmed, may be steeped in a solution of American potash, then in dilute nitric acid,

and afterwards in spirits of naphtha, and when well brushed out in naphtha it should be left to dry.

"After the substance has been prepared in the manner above described, it may be softened or rendered in some degree plastic by means of steam. And when in the softened state, it can be moulded into any desired shape, or the material may be steeped for about an hour and a half in a hot solution of common soda, then applied (while hot) to the prepared frame or moulds, where it should be left to dry, or while on the moulds, it may be steeped for about three hours in a solution of nitrate of lead, and then left to dry. The prepared substance then contracts and adheres to the mould, or, if the moulds are prepared to take to pieces, they can be removed, and the prepared material will remain the shape of the mould.

"Another mode of preparing the material is, after trimming, to steep it for about three hours in hot water, or water rendered slightly alkaline. I then stamp, emboss, press, or pierce it, as may be required. When thus shaped, it should be removed from the die-press, and hardened by steeping for about an hour in a hot solution of nitrate of lead; and. in some cases, I afterwards steep it in a hot solution of common alum, or in sulphate of alumina.

"Another mode consists in steeping the material (after carefully trimming and cleansing it) in a warm and very dilute solution of sulphuric acid, and after this I steep it for about three hours in a solution of corrosive sublimate, or in nitrate of lead, or in a hot solution of alum, or, if desired, two or more of these hardening solutions may be used in succession. It may

then be left to dry, and subsequently steeped in a compound solution composed of spirits of wine, or methylated spirit, or pyroxylic spirit; 20 parts linseed oil; 20 parts rosin; gum thus, or asphaltum 20 parts, turpentine 10 parts, shellac 5 parts, sandarac 5 parts. I then remove it to the drying-room, and when dry it is to be softened by steam, and then laid under pressure between sheets of warm iron, glass, or other material, taking care to protect the grain by blankets, flannel, or felt.

"It should be left till quite dry and hard, after which it may be cut up and treated as ordinary horn, and converted into scales for knife-handles and cutlery purposes. In order to utilize the waste pieces that result from cutting the prepared material into the required form, the substance may be reduced to a gelatinous mass and used in this state for plastic purposes. To effect this object, the material is to be cut into small pieces and then boiled, either in an open vessel or in a close vessel, under pressure, in hot-water or water rendered alkaline, until the substance is rendered quite gelatinous. The superfluous liquid is then to be drained off, and the mass is hardened by running it through a solution of nitrate of lead. Sometimes the material may be steamed until reduced to a soft state, and then submitted to the action of a press, in wooden moulds at first, and afterwards in steel dies.

"Another method of operating upon the substance consists in reducing it to fine powder by grinding, and then mixing the powder with a strong solution of glue, adding thereto a portion of alum and powdered

rosin, and then amalgamate the whole till it arrives at the consistence of putty. Or, the pulverized substance is mixed with coal-tar, or a solution of bitumen or asphaltum in any suitable solvent; the mass may then be rolled out and submitted to pressure in moulds or steel dies, as may be desired. The articles when made with a mixture of coal-tar or asphaltum should be submitted to a baking process at 300 to 500 degrees of temperature, whereby the articles will be hardened. This latter composition, when moulded, has the appearance of carved wood, and when dry, it should be brushed over with oil and polished by friction."

Mr. Ghislin also proposes to extract the colouring matter from the substance, and to give it the appearance of ivory, by submitting it to the action, first, of a warm solution of soda; second, of sulphurous acid; third, of chloride of lime; and fourth (if required) of chlorine dissolved in water, or in the form of gas. The bleaching operation may be repeated until a pure white is obtained; and then picric acid, mauve, magenta, or other dyes, may be applied, and various colours thereby imparted to the substance. Other colours may be produced by various means. If black be required, a compound of logwood and nutgalls can be prepared, and the material steeped in the hot liquor. Another colour may be produced by steeping logwood and alum together, and submitting the substance while quite hot; but to produce a variegated brown so desirable in imitating horn, the external surface of the natural protuberances of the substance should be rubbed off with fine emery paper,

and a varnish composed of shellac dissolved in methylated spirit, should be applied. Sometimes copal varnish may be advantageously used, and at other times gold or bronze powder, ultramarine blue, or other pulverized colouring matters, may be applied.

---

## THE USES OF LICHENS.

Dr. W. L. Lindsay, of Perth, in a series of between 500 and 600 experiments, the results of which were communicated to the Botanical Society of Edinburgh, in 1852-4, has called attention to the fact that we possess in our own island lichens capable of furnishing dyes nearly, if not quite, equal in beauty to orchil, cudbear, and litmus. He pointed out that certain genera and species of lichens which are abundant in Scotland, and could be collected with comparative facility, and at a very moderate expense, might be tried with advantage on a large scale as substitutes for the foreign lichens heretofore employed. Since he wrote this, however, the chemical discoveries and results of the application of coal dyes have greatly lessened the value of the lichens as dye stuffs.

Still the subject is worthy of being followed out by the manufacturer on the one hand, and the chemist on the other. 1. On account of scientific interest, the field being new and open, and at the same time most promising of good results; 2. Were it only with the view of further developing the economic resources of our own country; and 3. Because the substitution

of home for foreign dye-lichens promises to be ultimately remunerative.

The chief tint educible from lichens which can be of any permanent utility in the arts is red,—brown is also useful in a minor degree. The collection and transport of lichens for the purpose of examining their colorific powers is very easy, viz., by simple desiccation and packing; by drying and pulverizing; or by precipitating the colorific principles from a lime solution, or a decoction by acetic or muriatic acid.

The lichens richest in colorific principles, capable of yielding valuable colouring matters, are crustaceous and foliaceous species of a pale or whitish colour—whose alcoholic or aqueous infusion is nearly devoid of colour—which grow on rocks or stones, and in mountainous countries, or on sea-coasts.

Ascending to the verge of eternal snows, and descending to the ocean level, with a geographical diffusion that is co-extensive with the surface of our earth, it is difficult to say where lichens shall not be found. There are myriads of small rocky islets in the boundless ocean, and there are thousands of miles of barren rocky coast and sterile mountain range in every part of the world, which, though at present unfit to bear any of the higher members of the vegetable kingdom, are yet carpeted and adorned with a rich covering of lichens, and of those very species, too, which are prolific in colorific materials.

If commanders and masters of ships were aware of the value and uses of these lichens, which cover many a rocky coast and barren island, they might, with a slight expenditure of time and labour, bring home with

them such a quantity of these insignificant-looking plants as would realize considerable sums, to the direct advantage of themselves and the shipowners; and consequently to the advantage of the State.

A new branch of trade has recently sprung up in Calpentyn, Ceylon. An English gentleman who visited that island as the agent of some large manufacturing firms at home, discovered specimens of the *Roccella tinctoria*, finer than any hitherto exported from Aden or Western Africa, which produces the valuable purple dye. $4\frac{1}{2}$ tons of it were collected and shipped in a very short time. Specimens were shown at the International Exhibition. In British Kaffraria this lichen has also been lately found, and favourably reported on by Sir W. J. Hooker.

*Roccella fusiformis, tinctoria, hypomecha, flaccida,* and their varieties, under the common name of Orchilla weed, are the species usually met with in this country. They are imported from various parts of the world, as the Canary and Cape de Verd Islands, the Azores, Angola, Madagascar, Mauritius, Madeira, South America, Cape of Good Hope, &c. In commerce they receive the name of the country from whence they have been derived.

The largest quantity and best kind of Orchilla weed is obtained from the Portuguese settlements in Africa, and sent to Lisbon. The average annual quantity distributed from Lisbon to other countries in the three years ending 1859, was 3,700,000 lb.

*Lecanora tartaria* was formerly the principal lichen used in the preparation of the dye called cudbear. Cudbear is, however, now obtained not only from this,

but also from a number of other lichens, as the species of *Roccella*, *Gyrophora pustulata*, *Lecanora perella*, *Parmelia perlata*, *Variolaria delbata* and *orcina*, &c.

Orchilla weed is extensively used in this country and elsewhere in the manufacture of purple and red colours, called orchil, or archil, and cudbear. In Holland a blue colour called litmus is also prepared from the same lichens. A decoction of Orchilla weed possesses mucilaginous, emollient, and demulcent properties, and has been used in coughs, catarrhs, &c.

From Burmah I have received a specimen of Orchilla weed (*Roccella phycopsis*), which is apparently rich in colouring matter, and equally valuable with the ordinary *Roccella tinctoria* of commerce, of which species Dr. W. L. Lindsay considers it merely a branched variety. Varieties of *Roccella fusiformis* are collected and used for dyeing in India and Ceylon. I have not seen *R. tinctoria* from those localities, but it is probably collected and used, as a branched variety is employed at Burmah.

A dye lichen, *Alectoria sarmentosa*, is collected in Ceylon, under the name of Jaffna Moss, for tinctorial purposes. I have only succeeded in discovering it in the East-India Museum, in the shape of a very small fragmentary specimen. *Usnea barbata*, and its variety *florida*, chiefly the latter, are collected for dyeing in Ceylon and on the Peninsula of India, under the name of *Caranja Moss*. Other species are sometimes included under this name. Dr. W. L. Lindsay informs me that some years ago he saw in the herbarium of the Royal Botanic Garden, Edinburgh, a dye lichen from Saharunpoor, sent by

Dr. Jameson, and labelled *Borrera ashneh,* a specific name which is not to be found in any work on lichens with which he is acquainted, and which specimen he considers to be *Parmelia Kamtschadalis.* In Dr. Lindsay's "History of British Lichens," the generic name *Usnea* is stated to be derived from the Arab, *Achnêh,* or *Achnen,* a generic term for all lichens. In India species or varieties of *Usnea* are amongst the most common of all lichens. Appended to a specimen of *P. Kamtschadalis,* in the East-India Museum, are the following remarks :—"*Ashneh* of Arabs, *Chulcheleera* of India, the old *Usnea* of Materia Medica. *Alectoria Arabum,* Ach., *Borrera Arabica,* Royle." To which is added, in the writing of the late Dr. Royle, "Certainly distinct from *Alectoria Arabum,* Ach., as figured by Dillenius." This specimen appears to differ in no respect from the *Parmelia Kamtschadalis,* Eschweiler.

A mixture of dye lichens employed at Saharunpoor for dyeing, contains *Parmelia Kamtschadalis, Parmelia perlata,* and its variety, *Soredata, Usnea florida, Ramalina calicaris,* and fragments of *Physcia.* In this mixture the first-named species constitutes the greatest proportion.

Under the name of Jetamashee, a mixture of lichens including *Parmelia Kamtschadalis, P. perlata, U. florida,* and *Ramalina calicaris,* is employed at Patna for dyeing purposes. It resembles another mixture, which is known under the name of *Chulcheleera,* also employed for a like purpose in other parts of India. The first species (*Parmelia Kamtschadalis*) predominates in the Jetamashee.

A dye lichen under the name of Ratti-nara was shown at the Madras Exhibition of 1855. Not having seen it, I am ignorant of the species included under the above name. Probably it is only the same as that already described under *Jetamashee*; and, coming also from Nellore, it is, without doubt, identical with the *Ratti-pu*, so that the three are but local names for the same substance.

In 1857, specimens of lichens, under the name of *Ratti-pu* (stone-flower), were received from Nellore by the Commissioners of the Madras Exhibition. The jury requested Dr. A. J. Scott to report on their value. His report stated, "The lichens examined by me do not appear to possess any very well marked dyeing properties. By the mode of testing, however, employed by Westring, of Stockholm, a yellowish fluid has been obtained through the agency of ammonia and chloride of ammonium, which imparts its colour to cloth immersed in it."

The lichens, known or described under the names *Ashneh*, *Ratti-nara*, *Ratti-pu*, *Chulchelecra*, and *Jetamashee*, appear to be identical, and the chief species constituting the mixture is *Parmelia Kamtschadalis*.

Lichens contain starch, gum, and dyes. Willemet gives a list of forty-one species, having medical and economical uses. Amoreux has furnished analyses of them; and Westring gives their dye properties.

*Lichen farinaceus* and *glaucus* yield gum as transparent and tasteless as gum arabic.

*L. pulmonaris*, gum with a bitter taste. These lichens yield one-eighth of their weight of gum.

*L. Prunashii*, steeped in water, becomes transparent like animal membrane.

*Cetraria Islandicus* and all broad-leaved lichens, yield mucilage or gum.

*Lichen fraxineus, caninus,* and *caperatus* yield gums; the last dyes a yellow colour when ammonia is added.

*L. barbaratus, plicatus, fastigiatus,* and *fraxineus* also yield gum.

*L. pertusis*, with lime and sal-ammoniac, gives a brown colouring matter.

*L. ventusis* dyed wool a brown colour, and the colour resisted alkalies.

*L. hœmatoma* yields a wax-yellow colour.

*L. coralinus*, by simple infusion with salt, dyes wool yellow, and alone gives a permanent deep brown.

*L. pseudo-coralinus*, a fine orange colour, which is brightened by muriate of cobalt.

*L. tartareus*, a fine brown colour.

*L. centrifugus*, with fixed alkalies, yields a fine wax-yellow colour; with common salt and nitre, an orange colour.

*L. saxatilus*, with soda, a yellow colour; with muriate of soda, a nankeen colour; with nitre, an orange colour.

*L. physodes*, several shades of yellow and brown.

*L. juniperus* and *furfuraceus*, yellow and brown.

*L. tenullus*, yellow, olive, and reddish brown. The same colours from many leafy lichens.

*L. croceus*, with lime and sal-ammoniac, a red colour.*

There is a marked resemblance between the lichen

* Thomson's "Chemistry," iv. p. 287.

known as Oak lungs (*Sticta pulmonaria*) and *Cetraria Islandica*, the well known Iceland moss. Like that lichen, *Sticta pulmonaria* contains gum, starch, bitter and astringent principles, and a brownish colouring matter. Its nutritive and demulcent properties depend upon the presence of the former two, viz., the gum and starch. The starch, however, contained in it is of too small an amount to be of itself of much practical use. An article of diet, which is said to be very light and pleasant, is, with little difficulty, obtainable from this plant, in the following way:—After having thoroughly disengaged from it all extraneous substances, let it be steeped in a weak solution of some alkali, as of carbonate of soda or potash, in order to neutralize the effect of the bitter principle already mentioned as existing in it, which would otherwise impart a disagreeable taste to the article to be prepared. Then let it be taken out and floated in cold water for a minute or two, that any of the solution adhering to it may be removed. On being boiled for a short time in water, sugar having been added during the process, and then allowed to cool, it will be found to yield a jelly of a brownish hue, which is due to the presence of colouring matter extracted by the boiling water. To give this jelly an additional flavour, wine or spices may be added. It was at one time, in Britain, a favourite article of diet for invalids, possessing tonic and nutritive properties.

The bitter principle contained in it has, in Sweden and Siberia, been applied to the purposes of the brewer as a substitute for hops. The monks of a certain monastery in the latter country acquired quite

a reputation for the beer which they brewed, having been accustomed to flavour it with the bitter principle of this species of *Sticta*. It is also employed in France, &c., for the production of a brown dye.

Under the name of Iceland moss, *Cetraria Islandica* is collected in considerable quantities on the Carpathian mountains, where it grows in masses of five or six feet in height. Yielding a nutritious starch, this lichen is used in medicine, and forms rather an important article of commerce. It has to go through a long process before it can be rendered sufficiently palatable to be used as food. It is first soaked in water, till the bitterness is extracted, and then boiled in milk. A kind of bread is also said to be prepared from it.

This lichen may be deprived of its bitterness either by heating it twice in water to near the boiling point of Fahrenheit, or by digesting it in a weak alkaline solution, formed by adding half an ounce of carbonate of potash to about a gallon of water, and then washing it with clean water.

To make a jelly of Iceland moss, procure two pounds of the moss; put into an earthenware basin sufficient boiling water to cover it, and place upon a hob or other warm place for half an hour; drain the moss, and boil it in two and a-half gallons of fresh water for one hour, adding one ounce of isinglass; strain, and then mix the waters of the two boilings, and let it stand to clear. Boil the clear liquor till it decreases so as to become stiff jelly, add six pounds of fine lump sugar, two ounces of French brandy, and half an ounce of orange flower water. This, dis-

solved in a little water or milk, makes an agreeable and strengthening beverage for an invalid.

Those who are desirous of knowing precisely the chemical composition of this lichen, will find a chemico-physiological examination of it in a paper by Drs. Schnedermann and Knop, in the *Pharmaceutical Journal*, vol. v., p. 427, translated from the "Annal. der Chemie und Pharm."

Two species of *Lecanora*, namely, *L. esculenta* and *affinis*, form important articles of food, both to man and other animals, in Persia, Armenia, Tartary, &c. They appear in some seasons in such enormous quantities, that in certain districts they cover the ground to the depth of several inches; and the natives believe that they fall from heaven. *L. esculenta* is also found in Algeria, Asia Minor, &c., &c. Dr. O'Rorke, in a recent communication, has endeavoured to prove that this substance was the true manna of the Hebrews—that which fed them with regularity for forty years in the wilderness.

## THE USES OF PEAT.

THE raw materials of some of the most important manufactures of the United Kingdom, were not known before the present century to possess those properties which chemical science has since discovered in them, and which the manufacturer is now enabled to apply so largely to his own profit and to the use of the public. Among the most abundant of such materials, peat was, until lately, considered a mere fuel, render-

ing the districts occupied by it unfit for agricultural purposes, except at a cost wholly excluding profit: into its *chemical* properties and its commercial capabilities, no one thought of inquiring; of late, much more attention has been given to the subject.

Ireland possesses in its peat a great source of wealth and profitable employment, and all that is wanted are capital and science to make the possession available to the public use. The total area of Ireland is 20,000,000 of acres. The whole extent of bog was estimated a few years ago at 2,830,000 acres; nearly one-seventh of the entire surface of the island. Some portion of this, however, has lately been reclaimed. With this immense magazine of wealth at command, it is not too much to assume that the peat tracts may become to Ireland what the coal mines are to England, or steam-power to the English, Scotch, and Welch manufacturers, sources of industry, wealth, and public enterprise. Meaux in France, and Tours, are now lighted with gas made from peat, and a society has been formed there for the production of gas from peat.

A few years since a company was established in Ireland, under the name of the Irish Peat Company, for the purpose of operating upon peat, and obtaining from it all the chemical matters which it was known to contain. The company carried on their operations for some time under the able direction of Mr. Reece, who succeeded in obtaining from 775 tons of peat, which were operated upon as an experiment, the following products, viz.:—

| | | |
|---|---|---|
| Ammonia | .. .. | 1 ton 4 cwt. 1 qr. |
| Naphtha | .. .. | 77½ gallons. |
| Lubricating oils | .. | 1,162½ .. |
| Paraffin | .. .. | 2,325 lb. |

| | | | |
|---|---|---|---|
| The market price of these products was set down at .. .. .. | £565 | 18 | 0 |
| The cost of cutting the peat and of chemical re-agents and labour was | 264 | 15 | 10 |
| Showing a profit on 775 tons of peat and 22 days' work, of .. .. | £301 | 2 | 10 |

From this, something must be deducted for the wear and tear of machinery, salaries of officials, and some other minor changes; but, on the other hand, credit has to be taken for the peat charcoal left as a residuum, and which was set down as worth 42*s.* per ton.

Notwithstanding these brilliant prospects, the company, for some reason, did not succeed in a pecuniary point of view, and is now, I believe, dissolved, and the property sold to a private individual, who intends to carry on the works, but in a somewhat different manner to that adopted by the company.

The chief products to be obtained from peat are—

I. *Sulphate of Ammonia.* This salt is principally used in the preparation of muriate of ammonia or sal-ammoniac, in the manufacture of alum, and in producing the other salts of ammonia, such as the sublimed carbonate used by bakers, and the solution of ammonia, for the purposes of the orchil makers, dyers, &c.; and it is most extensively employed as a manure, for which purpose it commands a high price and an unlimited market. It has been hitherto com-

paratively difficult of attainment. Vegetable matter, when azote is one of the elements, as the gluten of wheat, yields ammonia; coal-soot also contains it; but the decomposition of coal, effected during the production of carburetted hydrogen, for the purpose of gas illumination, forms at present the chief source of ammonia, which by combination with sulphuric acid, is converted into sulphate.

II. *Acetate of Lime,* composed of acetic acid and lime, may be found by dissolving carbonate of lime in the acid; but it can also be distilled from the peat. It is a salt extensively used for producing the ferruginous and aluminous liquors used by calico printers, and it is also the source of acetic acid for various other purposes.

III. *Naphtha, or "Wood Spirit."*—This important chemical agent is produced from peat in great quantities. It is yielded in a pure, colourless, limpid state, resembling in its properties spirits of wine, and differing only in its odour; and from its properties of combining in all proportions with alcohol, ether, petroleum, &c., it is largely used by hatters and varnish makers, in place of spirits of wine, for dissolving the resins used in their respective trades.

IV. *Paraffin.*—Little was known of this valuable vegetable product till a few years since it was determined by several foreign chemists of celebrity to be a "solid carburet of hydrogen."

Dr. Christison obtained it from the petroleum of Rangoon, and called it *petrolus;* and Dr. Reichenbach discovered its presence in the products of distilled beech-tar. In appearance it is a fatty, but

rather firm solid, wholly inodorous; at 110° F. it melts into an oily liquid and evaporates without change; it burns with a pure white flame. It is soluble in alcohol, oil of turpentine, naphtha, and the fat oils when heated, and it unites with spermaceti, wax, and most fatty bodies by fusion. It consists of 6 of carbon and 1 of hydrogen. These singular properties fit it in a remarkable manner for the manufacture of candles of a high degree of purity, which are found in use to emit no smell and to give an intense colourless light.

V. *Hydro-carbon solvent.*—This oil, which is of a thin transparent quality, is well adapted for dissolving gum elastic, gutta-percha, and various resins, and would, therefore, in all probability, command extensive use in the preparation of cheap varnishes for rendering sailcloths and other textile fabrics impenetrable to moisture.

VI. *Fixed Oil.*—This body, in combination with tallow, would obtain general use in lubricating machinery, and, mixed with common oils, might greatly assist the manufacturer of a cheap lamp-oil.

Sir Robert Kane, by order of the Chief Commissioner of Woods, conducted an investigation in 1851, and submitted a valuable report on the nature and products of the process of the destructive distillation of peat, considered specially with reference to its employment as a branch of manufacturing industry; the object being to ascertain the necessary facts regarding the products of commercial value. The following was the course pursued:—

Specimens of turf representing the several ordinary

varieties were experimented on, and the results examined. The products of the distillation were collected as : 1. charcoal, 2. tar, 3. watery liquids, 4. gases. The relative quantities produeed, by 100 parts of heat, were found to be :—

| | Average. | Maximum. | Minimum. |
|---|---|---|---|
| Charcoal .. | 29·22 .. | 39·13 .. | 18·97 |
| Tarry products | 2·78 .. | 4·41 .. | 1·46 |
| Watery products | 31·39 .. | 38·12 .. | 21·82 |
| Gases .. .. | 36·61 .. | 57·47 .. | 25·02 |

The peats yielding those proportions of products had been found to contain previous to distillation, as dried in the air, a quantity of hygromatic moisture, and to yield a proportion of ashes, in 100 parts, as follows :—

| | Average. | Maximum. | Minimum. |
|---|---|---|---|
| Moisture .. | 19·71 .. | 29·56 .. | 16·39 |
| Ashes .. .. | 3·43 .. | 7·90 .. | 1·99 |

The several products of the distillation thus carried on were most specially examined for the several materials of which the quantities and commercial value had been the principal sources of the public interest of this inquiry. The inquiry having reference to the technical objects of the proeess was earried on by examining the produee of—

I. Tar for ........ 1. Volatile oils.
,, 2. Fixed (less volatile) oils.
,, 3. Solid fats, or paraffin.
,, 4. Kreosote.
II. Watery liquids for 1. Acetic acid.
,, 2. Ammonia.
,, 3. Pyroxylic spirit.
III. Gases for illuminating and heating powers.

The following numbers will indicate the per eentage

results obtained in average. In seven series of distillation, in close vessels, there was obtained from 100 parts of peat—

| | Average. | Minimum. | Maximum. |
|---|---|---|---|
| Ammonia .. .. | 0·26 .. | 0·18 .. | 0·40 |
| or as | | | |
| Sulphate of ammonia | 1·03 .. | 0·70 .. | 1·56 |
| Acetic acid .. | 0·19 .. | 0·07 .. | 0·23 |
| or as | | | |
| Acetate of lime .. | 0·28 .. | 0·11 .. | 0·42 |
| Pyroxylic spirit .. | 0·14 .. | 0·09 .. | 0·19 |
| Volatile oils .. | 0·79 .. | 0·57 .. | 1·26 |
| Fixed oils .. .. | 0·55 .. | 0·26 .. | 0·76 |
| Paraffin .. .. | 0·13 .. | 0·02 .. | 0·19 |

It is thus seen that the proportions of those products vary within wide limits, which are determined by differences of quality of the turf, or temperature in the distillation. Several trials were made to determine the amount of kreosote present in the tar, but although its presence could be recognized, its proportions were so minute as to render its quantitative estimation impossible.

Where are farmers to obtain an abundant supply of manure when guano becomes scarce? Peat-soil might probably be used as an excellent substratum for artificial manure.

Nature has provided ample resources for the necessities of the human race; to develop these resources is the province of man. It must be evident, however, to all intelligent people, that the more numerous our race becomes the more will man be beholden to science for the adequate development of these resources. Ignorance is opposed to science; it has shown its antagonism in anti-steam-power riots, and opposition

to the introduction of machinery; but science must triumph; it will become, or rather it has become, indispensable to society.

That bogs—those stores of nature's vegetable conserve, the peat—are destined to play a prominent part in agriculture, seems to me very probable. What extensive tracts of this substance we find scattered widely over the world!—in many parts useless—nay, in some cases worse than useless, spreading ague and fever far and wide. The use of peat as fuel is, indeed, extensive; in many parts of the continent of Europe it is almost the only fuel used. Hundreds of people find employment in transporting it on the Elbe to Hamburg, and other markets on that river. In Jutland, in Denmark, extensive bogs exist, many of which afford excellent fuel both for domestic purposes, and for burning lime, bricks, &c. Some kinds make very hot fires: I have seen in a limekiln in Denmark, where peat was used, vitreous slags produced that indicated a high degree of heat; there is also a kind in the neighbourhood of the small town of Grenaa, called Ramten-turf (from the place where it is obtained) that produces good charcoal which is used by smiths. But large tracts of bog-land lie undisturbed, only producing rank grasses on which herds of lean cattle graze during the summer.

But, to come nearer home, the bogs in Ireland and some parts of Scotland would furnish an abundant supply of peat-soil, if it were once found how to turn it to profitable account. I am not aware that this kind of soil has ever been made much use of as arable land; I have seen oats and flax grown on it on the Con-

nent, but in all cases the crops were poor. However, in the Hebrides they get, on a small scale, very fair crops of oats from it by the following mode of culture:—They first set fire to the heather, and then spread sea-weed in strips of six or eight feet width on the ground; on each side of the sea-weed-covered patches they dig a trench two or three feet deep, throwing the soil from the trenches over the sea-weed; when this soil is loosened a little with a spade, it is ready for the seed.

It appears that the sea-weed in this case exercises a great influence in making the peat-soil productive; yet it seems strange that a soil of this kind, composed almost entirely of vegetable matters, should require more *vegetable matter* as manure.

Now, the principal use of manure undoubtedly is to furnish the *minerals* required by vegetation in a *soluble* state. In the Channel Islands, where vraic (the local name of seaweed there) is extensively used as fuel, it is found that the ashes are more beneficial as manure than the fresh weed; and peat-ashes are considered of great value for rye-land on the Continent. We find that where water percolates the soil, it renders it unfruitful; it evidently washes away dissolved minerals, and robs the vegetation of its nutriments. Where the land is too wet, and the contained water stagnant, the dissolved minerals may be too largely diluted: besides, the water will prevent the air from acting on the soil, and thus prevent farther solution. Land in this state *therefore* requires draining. The quantity of suitable mineral substances that water ought to hold in solution to sustain vegeta-

tion may be extremely small, but one can conceive that the supply ought to be continuous.

Manure may furnish mineral matters suitable to nourish plants, in the first place, when it contains them in such a state that they are acted on directly by air, moisture, temperature, &c., so that they become by degrees soluble; secondly, by acting chemically on the minerals composing the soil; and thirdly, by facilitating the decomposition of organic substances, setting free their contained minerals. The action of ammonia as manure is, perhaps, of this latter kind.

Now, peat-soil is evidently not prone to spontaneous decomposition; hence its sterility *per se:* but if it were laid up in heaps, mixed with sea-weed, refuse fish, &c., the action of these substances on each other might tend to produce a most valuable manure. In the case of fish, the peat-soil would probably absorb evolved ammonia, and other volatile products, the greater part of which might otherwise have gone to waste. Quicklime and many other substances might perhaps also be found useful. But it is vain to speculate in details; I have only attempted to throw out hints of a general nature, and experiments alone can test their value.

I shall now quote from a very interesting paper read at the Society of Arts, in May, 1860, by Mr. W. E. Newton, "On the Employment of Peat in the Useful Arts, together with an account of some recent improvements in the preparation of it for various useful purposes."

"It is scarcely necessary to say that peat, as an article of fuel, has been for a long time in very general

use in various parts of the United Kingdom, as well as on the continent of Europe, and it is a matter of astonishment to find that although peat fuel has been very extensively used in many parts of the continent for metallurgic purposes, it has never been practically used for such operations in this country.

"A true peat-bog, or flow-moss, as it is called in Scotland, is a tract of ground generally almost level, often many miles in circumference, consisting of a light, soft, fibrous substance, of several feet deep, so inflammable as to be used as a common fuel. It is easily cut with a spade, and when so cut and exposed to the air, it changes in a few minutes from a dusky yellow to a blackish colour. The surface of a peat-bog is brown or dark in appearance, and even in the midst of summer is wet and spongy, and is commonly covered with heath, coarse grass, and moss in detached patches, the intermediate and wetter places bearing no vegetable productions. Most deep pit-bogs contain different qualities of peat. The upper part of the bog, or that near the surface, is light-coloured, soft, and spongy, and contains the vegetable remains but little altered. Deeper the peat is brown, denser, and more decomposed. The lowest stratum is still more dense, and when removed from the bog and dried, the mass of turf assumes the black colour, and nearly the density of coal, to which it approximates very much in chemical composition. Now, if the peat when taken from the bog be carefully examined, even the densest portions, or those taken from the lowermost parts of the bog, will be found to contain a large quantity of vegetable fuel, or roots distributed through the mass.

"The black or brown slimy or pasty portion of the peat consists of the decomposed vegetable fibres, while the rooty or fibrous portions of the mass consist of undecomposed vegetable fibres. The specific gravity of the light surface peat is 400, water being 1,000, and from this it increases in compactness and to nearly the density of coal. For all flaming fires, peat is applicable, and in its application to steam-boilers it is peculiarly useful, as there is no liability of that burning away of the metal which may arise from local intensity of the heat of coke or coal.

"Mr. Burstall, of Bristol, has published the results of his use of peat with a high-pressure engine. The steam was of 36 lb. pressure, and there were consumed 74 lb. of peat per hour. The quantity of water evaporated from the boiler per hour was on an average of 360 lb., which is nearly five times the weight of the peat used as fuel. The following results as to the comparative effective power of peat and coal have been furnished by Mr. Charles Wye Williams, and are derived from the working of the *Lansdowne*, one of the steamers of the Inland Navigation Company, which ply upon the Shannon with goods and passengers. Before the use of peat, a week's work, consisting of 49 hours, consumed 24 tons of coal, costing, at 15s. per ton, £18, or 7*s.* 5*d.* per working hour. To do the same work, there were consumed per week 315 boxes of peat, which at 7*d.* per box, costs £9. 12*s.* 7*d.*, or 3*s.* 11*d.* per hour, a little more than half the cost of coal. Mr. Williams, using well-dried peat, found that with a large waggon boiler, there were 3·8 lb. of water evaporated per lb. of peat, and

that it cost 3*s.* 7*d.* to evaporate 100 cubic feet of water. Now, this is $5\frac{1}{4}d.$ per horse-power per working day. When peat was burned in the furnace without Mr. Williams's peculiar mode of effecting perfect combustion, the cost per horse-power was $6\frac{1}{4}$d. From the experiments that were made at that time, it appeared that in Ireland the horse-power of steam costs per day in fuel :—

| | | |
|---|---|---|
| Using coals, whether British or Irish | .. | $7\frac{3}{4}$d. |
| ,, peat properly dried | .. .. | $6\frac{1}{4}$d. |
| ,, ,, burned on Mr. Williams' system | | $5\frac{1}{4}$d. |

"Almost all peat when taken from the bog is found to contain a large amount of water, and, as has been already stated, a considerable quantity of undecomposed fibre is mixed with the decomposed parts, which form the soft, slimy mass of the peat. These undecomposed fibres are found to consist of minute tubes filled with water, which they retain until it can either be driven off or evaporated by exposure to the open air, or by artificial heat, or be forced out by pressure. The presence of so much water of course materially detracts from the heating power of peat, and the peasantry and country people who use peat turfs as fuel adopt the practice (after digging or cutting the peat) of piling it up in rows on the ground, so as to let the sun and air act upon and dry it. After being exposed for some length of time, the peat will be sufficiently dry and hard for use, provided a heavy rain has not occurred in the meantime. It has been ascertained by experiment that the peat, even when considered dry, contains as much as 30 to 35 per cent. of moisture, and when

taken from the bog it must of course contain much more, a great portion of which must be got rid of before the peat can be used for any but the commonest and roughest domestic purposes. In order to remedy the inconvenience and delay of stacking the peat for drying, it has been proposed to express the water therefrom by mechanical means, and at the same time solidify it to such an extent as will admit of it being used as fuel which will stand a moderate draught or blast.

"From the experiments that have been made, it does not appear that the simple application of mechanical pressure to the sods of peat as taken from the bog is of any practical use. Wet peat from the bog contains as much as 75 per cent. of moisture, and to make one ton of dry peat four tons weight of turf must be dug from the bog.

"Experience has shown that much of this moisture may be got rid of by a judicious system of draining, and that the peat, if left *in situ* until the bog has been properly and systematically drained, will be considerably improved in quality as a fuel by becoming more compact, dense, and solid. Mr. Jasper Wheeler Rogers, of Robertstown, in the county of Kildare, has devoted many years to the study of this subject, and has brought forward a system of draining peat bogs which, in my opinion, leaves little to be desired. His plan is simple and effective, and aims only at assisting nature. Suppose it be intended to operate upon a moss of, say, 1,000 acres in extent; he first ascertains the lowest point at which he can obtain an outfall; he then commences at that point and drives a drain forward along the lowest

edge of the moss, and when he has cut this drain a sufficient distance in one direction, he begins at both ends to cut other drains at right angles to the first, thereby forming three sides of a square; these side drains having been made of sufficient length to inclose within the three sides, say 50 or 100 acres, a fourth drain, parallel with the first, but at the opposite end of the side drains, is cut, and thereby the entire enclosed area of 50 or 100 acres is cut off or isolated from the rest of the moss. The effect of this isolation or cutting off will be that the moisture from the enclosed area will be expressed by the pressure of the atmosphere and the superincumbent weight of the moss into the surrounding drains, and will run off at the outfall, and no moisture from the other parts of the moss will be allowed to enter the isolated part. In order to assist this operation, other lateral drains may be formed, and by this means the surface will be completely drained; the effect of this will be that the upper and more spongy parts of the moss will gradually subside, and become more compact and solid. All the drains must then be cut deeper, so that the moisture from a lower part of the moss may be expressed by natural pressure, and run off in the same way as is above-mentioned. But here it must be remarked, that instead of cutting the drains with straight sides, as usual, Mr. Rogers cuts them in steps or terraces. By this means he more easily gets rid of the water, and he runs no risk of his drains becoming filled up or stopped by the lateral squeezing in of the sides, as sometimes occurs in drains with straight sides. This operation of gra-

dually deepening the drains by cutting them down in steps, is proceeded with until the solid ground at the bottom of the bog is reached, by which time nearly all the water in the bog will have run off, and the peat, by gradually sinking as the water escapes, will have become more and more solid, until at last it will reach to nearly the density of coal, and will require but little drying when taken from the bog. In connection with this subject, Mr. Rogers has recently patented a most ingenious contrivance for drying peat, an operation which, by the ordinary stacking, requires many weeks of fine weather. Having found by experience, that stacked peat dried more rapidly in a cold, but moderately dry March, than in the hotter months of June, July, and August, Mr. Rogers was led to investigate the cause, and he came to the conclusion, that the stormy winds of March had more to do with drying the peat than the heat of summer and autumn. Having satisfied himself on this point, he determined, that when there was little or no wind to act on the peat, he would create an artificial storm for the purpose. He therefore cut his sods out into pieces about 12 inches long, by about 3 inches thick, and having placed them on wicker frames, in such a manner that the air could circulate among them, he placed these frames on a rotating apparatus, something like a merry-go-round, such as children ride on in fairs; and upon setting this apparatus in rapid rotation, the sods of peat whirled through the air with considerable velocity, and an artificial current or draught was thereby produced, of sufficient power to dry the sods in from twenty-four to forty-eight hours,

instead of them requiring as many, or twice as many days. It was found that this rapid motion through the air not only had the effect of drying the peat, but also of condensing or solidifying it, whereas the application of heat to drive off the moisture had precisely the opposite effect.

"The advantages resulting from the use of peat fuel are such as have induced many foreign manufacturers to use it in some branches of the iron manufacture. From the researches of a commission of French engineers, who, some years ago, by order of the French Government, published a report of their labours, we gather the following interesting information :—

"It appears that in the department of the Landes, France, there are iron-works at Ichoux, which consume turf only; the cost there is about 8s. per ton. Forty-five per cent. of turf and 23 cwt. of pig iron give one ton puddled iron. Twenty-six cubic feet of turf and 25 cwt. pig, yield 20 cwt. of bar-iron of superior quality.

"M. Muller, of Wadenhammer, a manufacturer of leading notoriety, has proved, by actual working test, that an equal quantity of turf charcoal, used in place of wood charcoal, produces a greater quantity of produce from the ore than the best wood charcoal.

"At Wachter Newnhammer, it was found that when equal parts of turf charcoal and wood charcoal were used in place of wood charcoal, solely, the quantity of iron was raised from 386 lb. to 464 lb., the quality being excellent.

"There are at Ransko, in Bohemia, iron works for

smelting, cupolas for re-melting pig, and reverberating furnaces, &c., for making bar and plate iron. The ore is but middling in quality. The fuel is turf and charcoal only, the turf being of light texture, and not in any way prepared or pressed. The fuel consumed to make one ton of iron is about 34 cwt. of turf and 30 cwt. of charcoal; the cost of the first is less than 9*s.*, the latter about £1. 4*s.*; smelting, therefore, costs about £1. 13*s.*, and the total cost of pig-iron about £3. 15*s.* per ton. The quality of the iron is the highest.

"In Bavaria there are iron-works similarly worked. One at Konigsbrunn carries on the whole operations of fusion, puddling, reheating, and rolling solely by peat fuel. The commissioners state that the turf is not pressed, but carefully dried by means of heat from separate fires or from the furnaces. Bertheir states the analysis of this turf to be

| | |
|---|---|
| Volatile matter .. .. .. .. | 70·6 |
| Carbon .. .. .. .. .. | 24·4 |
| Ashes .. .. .. .. .. | 5· |

30¼ cwt. of this turf to 22½ cwt. of pig produces one ton puddled iron.

"30 cwt. of dense turf to 24½ cwt. of puddled iron produces one ton small bars of fine quality.

"The apparent average is, that 32 cwt. of properly dried turf to 20½ cwt. pig, gives one ton castings; 30 cwt. turf to 21 cwt. flat iron, one ton plates.

"By compressing peat its value as a fuel for metallurgic operations is much increased; and when compressed peat is carbonised, it gives a fine coherent

coke, which contains very little ash. When the coking is properly carried on the peat yields about 30 per cent. of its weight of coke, and the density of this coke is greater than that of wood-charcoal, being found to range from 913 to 1,040. The iron furnaces of Voitumra give a still higher per centage of coke when the peat is coked in small vessels.

"The precise figures are :—

| | |
|---|---|
| Charcoal .. .. .. .. .. | 40·25 |
| Tar .. .. .. .. .. | 24·50 |
| Watery liquor .. .. .. .. | 14·00 |
| Gaseous matter .. .. .. .. | 21·25 |
| | 100·00 |

"The calorific effect of peat-charcoal uncompressed is about the same as coal-coke, while that of compressed peat-charcoal is, as before-mentioned, much greater. The value of peat-charcoal, whether made from compressed or uncompressed peat, is evident, as is also the increased value of iron made by means of such fuel. I take these to be incontestable facts; and it is almost incredible that so valuable an article as peat should have remained so long almost unnoticed and unemployed by our metal manufacturers. The neglect of peat as a fuel may and probably has arisen partly from its bulky nature, and partly from the open or spongy character of a great deal of the peat that is dried in the open air in the natural way, and which renders it inapplicable, or, at any rate, inconvenient, to be used as a fuel for smelting purposes. The compression or solidification of peat by ordinary mechanical pressure is an expensive and slow process when

applied to large quantities; and therefore, even although such an operation could be made effectual in expressing the water from the peat, the extensive and costly plant that would be required to work on a scale sufficiently large to meet a moderate demand would act, and no doubt has acted, as a barrier to extensive operations being carried on for this purpose.

"Mr. Rogers, and other gentlemen connected with Ireland, have for years been earnestly endeavouring, but almost without success, to direct the notice of iron-manufacturers to the extensive tracts of peat in Ireland and elsewhere, and which have to a great extent hitherto been looked upon as nearly valueless. Those gentlemen, in despair of inducing iron-manufacturers to direct their energies to the preparation and use of peat as fuel, have now for some time past been quietly but gradually bringing peat into use for other purposes of scarcely less value than as an article of fuel.

"It has been said that even the dearest kinds of peat, in a natural state, contain a large quantity of undecomposed fibres, which, being for the most part tubular, enclose a considerable amount of moisture, which adds to the weight of the peat. These tubular fibres prevent the peat from drying within a reasonable time, and also actually deteriorate its quality as a fuel. Struck with the knowledge of these facts and the practical difficulty of removing the water from the peat, either by mechanical pressure or by evaporation by the application of heat in the ordinary way, Mr. Buckland, of the Maesteg Iron Works, in Glamorganshire, proposed to separate the undecomposed

tubular fibres which contained the water from the black slimy mass which forms the valuable part of the peat. He proposed two different plans for doing this, one of which may be called the wet method, and the second the dry method. According to the first plan, the wet peat from the bog is thrown into a vessel filled with water, in which it is stirred for some time, so as to break up the mass and entirely separate it. The contents of the vessel are then allowed to subside, when the black, decomposed, and heavier portions of the peat will fall down to the bottom, while the rooty, undecomposed fibres will float above, and may be drawn off with the supernatant water. The black muddy sediment may, when sufficiently drained, be moulded into any convenient form and size of block, and when dry will be found to possess the hardness, appearance, and density of coal, and may then be used as fuel for domestic or manufacturing purposes. The brown, undecomposed fibres or roots which are run off with the water will present very much the appearance of finely-cut tobacco, and will be found to be a most excellent article of which to make some of the stronger and coarser kinds of paper. A process bearing some analogy to the wet process of Mr. Buckland, was invented some years since by Mr. Cobbold, of Mount Leinster, in the county of Carlow, who proposed to make artificial coal from peat, by grinding up and mixing the fibres, so as to form a homogeneous mass, which was subsequently moulded into any desired form. Mr. Cobbold produced a very dense black substance, which was capable of being moulded and of receiving

impressions from dies, or of being turned in the lathe, to form a variety of articles, but the process was found too expensive for the manufacture of fuel. The grinding operation was necessarily costly, and too slow to admit of dealing advantageously with large masses; but the inventor succeeded in producing a most beautiful article suitable for ornamental purposes. Mr. Buckland's dry process is the one he employs in the manufacture of fuel, and for preparing peat for conversion into charcoal. It is founded simply on the principle of separating the rooty or undecomposed fibres of the peat from the dark, slimy, decomposed parts, by straining the mass through a sieve-like apparatus, whereby the rooty fibres are kept back, while the decomposed slimy parts are allowed to pass through the perforations of the sieve. The apparatus whereby this is effected consists of a hopper or vessel, into which the peat as taken from the bog is thrown, and is carried down by means of a rotating vertical screw into a conical chamber or vessel made of metal, and having perforated sides. The rotating vertical screw not only carries the wet peat down from the hopper into the conical straining vessel, but forces the dark, decomposed, slimy parts of peat through the perforations or holes in the sides of the chamber, the size of the holes preventing the rooty portions or undecomposed parts from passing through. These latter are discharged from the straining chamber through an opening in the bottom, and are conveyed out of the machine by a pipe or conduit provided for the purpose. The conical straining vessel is about 3 ft. in diameter by 3 ft. deep, and is perforated

with about 40,000 holes, of one-eighth of an inch in diameter, and is surrounded by or inclosed within a metal casing, within which hot air is admitted for the purpose of partially drying the peat. The expressed peat, on passing through the perforations of the straining vessel, falls down on the outside in the form of short worms, something like small pieces of broken maccaroni. If it be desired to produce charcoal for manure, or for disinfecting and some other purposes, these worm-like pieces may be allowed to fall directly on to a hot plate or travelling metallic platform, heated from below, for the purpose of driving off any superabundant moisture that the peat may contain. This object will be further effected by causing a current of either hot or cold air to pass through the chamber (that surrounds the straining vessel), so as to carry off any aqueous vapours that may arise from the peat. The partially dried peat, when delivered from the machine, may then, if required, be stoved or further dried for a short time, and will then be ready to be converted into charcoal. If, however, it be desired to convert the peat into fuel or artificial coal for domestic or manufacturing purposes, the peat, as it falls from the perforations of the straining chamber, is received on the upper end of an Archimedean screw, which revolves in a close case, having at its lower end a die plate, through which the peat is expressed continuously, and as it exudes therefrom it is cut up into lengths of convenient size for removal from the machine to a drying-shed, where, in the course of from twenty-four to forty-eight hours, the prepared peat will become dry enough for use.

"In order to promote the drying of the peat as it passes through the machine, the heated gases from a furnace are made to heat the casing which surrounds the Archimedean compressing and delivering screws, so that when the peat is delivered from the machine but little subsequent drying will be required to render the fuel fit for use.

"It should be mentioned that every straining or separating machine is provided with one straining cylinder and expressing screw, and, in order to mould the expressed peat, four or more Archimedean or compressing screws and die plates are adapted to each straining chamber or vessel. The cost of such a machine complete, with moulding apparatus capable of delivering twenty tons of moulded fuel per diem, is £100. The straining machine alone, without Archimedean screws and moulding apparatus, will cost £30; and for preparing peat for being converted into charcoal to be used as a manure or fertilizer, or for a deodorizer, nothing more than the straining apparatus is required.

"Although the peat during this series of operations has been subjected to but a trifling pressure, it will be found to possess a hardness and density not easily attainable by the application of mechanical pressure in the ordinary way; and therefore the peat so prepared will, from its density, be found exceedingly valuable as a fuel, and, either in that state or when converted into charcoal, will be able to resist the pressure of a charge of iron in a high furnace, and the draught or blast to which it would be subjected in such a furnace.

"The conversion of the peat into charcoal is carried

on in closed retorts, and from the gases evolved from the retorts is collected a valuable product in the form of peat grease (a black unctuous substance) containing a variety of valuable matters well known to chemists. Mr. Buckland, in his operations upon peat, does not intend to carry out any of the elaborate processes which are necessary in order to resolve the crude grease into the various substances it contains; he prefers to leave this to other hands whose every-day occupation it is to operate upon analogous substances.

"I have been shown a specimen of compressed Irish peat, received from Mr. H. Hodgson, of Merlin Park, Galway, and Ballyraine, Arklow, equal in specific gravity to coal, but as an article of fuel quite superior; and it possesses the advantage of giving out no smoke, which makes it invaluable for use on board steamers and other purposes connected with machinery. It was prepared at the works of Mr. Hodgson, jun., near Athy, on scientific principles, and is a fair sample of the produce of the Irish bogs. Mr. Hodgson has already tested the peat on his property in Connemara, where he purposes to manufacture this important substitute for coals, which will be the means of affording a large amount of employment to the peasantry of both sexes. It is worthy of note that compressed peat may be manufactured at such a rate as to allow of its being sold at 10s. per ton—a circumstance of great importance when we consider the price of coals. Mr. Hodgson deserves the utmost credit for thus aiding in developing the industrial resources and the latent wealth of the country.

"Peat, when taken from the bog, sometimes contains

as much as 75 per cent. of water; therefore, to obtain 1 ton of dry peat, 4 tons of wet peat must be dug from the bog. The cost of digging and carrying the peat 100 yards, Mr. Buckland sets down at 4d. per ton, or 1s. 4d. for the 4 tons of wet peat required to produce 1 ton of dry. To this must be added the labour attending the working of the machine, the cost of fuel, and other charges on the spot, which may be set down at from 1s. 6d. to 1s. 8d. per ton of prepared peat, making a total cost of about 3s. to produce 1 ton of dry peat fuel ready for use. From 2½ to 3 tons of dry peat, valued at say 12s., are required to produce 1 ton of peat charcoal worth from 30s. to 35s. per ton; and during the process of conversion each ton of peat will yield 1 cwt. of black peat-grease, valued at 25s. per cwt., at which price there is a large market for the article. The only deduction to be made from these figures is the cost of coking and the wear and tear of retorts. Little more than the very commonest unskilled labour is required to cut the turf and work the machines and apparatus; the peat is not required to be cut of any peculiar form and dimensions, as is now the case with air-dried peat which requires careful stacking, and the only part of the operations which requires any special knowledge on the part of the workman, is the coking process. The whole plan of working is therefore eminently adapted for parts of the country where skilled labour and anything more than a very moderate amount of capital is available.

"We have been hitherto considering the peat principally as an article of fuel, either in the form of hard

dry lumps, of convenient size to be used as coal, or in the form of charcoal, to be used principally in the manufacture of iron. Important as these applications of peat undoubtedly are, they by no means exhaust its useful capabilities, for, as we have seen, valuable chemical products may be obtained by submitting the peat to distillation. For instance, the prepared peat will be found to yield, upon distillation, large quantities of carburetted hydrogen or illuminating gas, of the best quality, giving also as a product the peat-grease above mentioned, and charcoal for fertilizing or deodorizing purposes. Apparently, however, much remains to be done before the delicate chemical processes required to obtain many of the valuable chemical products alluded to can be made commercially useful; but the employment of peat charcoal as a manure or fertilizer, as well as a valuable disinfecting agent, is now established, and is extensively used.

"As a deodorizer of feculent matter, peat charcoal is the most effective substance known to chemists; it absorbs all noxious gases arising from such matters or from putrescent bodies, and therefore to the sanitary chemist it is as important as to the agriculturist. The very strong affinity of the noxious gases and odours evolved from feculent and putrefying substances for peat charcoal led Mr. Rogers to inquire whether this substance might not be beneficially employed for some medical purposes, and, with the assistance of one or two medical friends, he carried on for some time a number of experiments, commencing by applying the charcoal in the form of a poultice or dressing for offensive ulcerous sores. The charcoal

had a highly beneficial effect in such instances, not alone in totally destroying the smell by absorbing the gases, but also in cleansing the wounds. It was also found useful for absorbing the odours arising from consumptive patients in the latter stages of the disease. The first experiments being so successful, naturally led to the use of the charcoal internally; it was found to correct putrescence and absorb those gases within, which, if they do not produce evil to the health, at least destroy comfort. The result of these experiments, and a continuous and pretty extensive use of the charcoal, have demonstrated that it may be used with advantage as a remedial agent in indigestion or dyspepsia, and its results, viz., flatulence, heartburn, acidity of the stomach, waterbrash, sick headache, impurity of the breath, palpitation of the heart, throbbing of the brain, distension and sense of fulness, giddiness, and the other usual attendants of a disordered stomach. In all diseases of the chest, sore throats, diphtheria, or chronic bronchial affections, peat charcoal has been found highly useful, as well as in cases of diarrhœa, colic, and English or Asiatic cholera. Dr. Hawkesley states that he has 'used carbonized peat most extensively in the treatment of various disordered states of the digestive powers, with the most gratifying results.' Dr. Fergusson, formerly of King's College, says:—'I have used the peat charcoal extensively in the wards of King's College, and invariably with excellent success.' He further says:—'In some instances hitherto it has been almost impossible to keep patients in any degree of comfort, the offensive smell of their wounds causing

the utmost annoyance. I then thought of mixing the powdered peat charcoal with the poultice—the effect was in a manner perfect. There was no longer that offensive stench so peculiar in such cases.' Again, he says—'In sloughing sores, and in certain forms of cancer (in which cases the smell is usually bad), I have been equally well pleased, and I have this preparation in almost constant use.' Such is the testimony of two eminent physicians in this country.

"In France, also, the subject has been investigated, and the highly beneficial effects of peat charcoal have been proved by a scientific commission appointed by the Government. The use of peat as a fuel and for metallurgic purposes will, after all, be its most extensive application.

"The superiority of iron made with charcoal over that made by the use of pit-coal, is so well known that it will be altogether unnecessary to insist upon it here; and yet for our best brands of charcoal iron we depend on the foreign manufacturer, when we have, at our own doors, every requisite to produce iron of the finest quality, and materials in abundance to produce charcoal in every way fitted for metallurgic operations.

"It is to be hoped, now the means have been pointed out of obtaining peat and converting it into charcoal at a very moderate expense, that iron manufacturers will turn their attention to the application of peat fuel to this important manufacture, and that we may not henceforth be obliged to go abroad for the iron necessary for making steel, and for other purposes where iron of the best quality is required."

Let us pass now to the consideration of waste animal substances, and we will first deal with

## OLD WOOLLEN RAGS AND SHODDY.

Mrs. Traill, in her "Canadian Settlers' Guide," tells us that rag-carpets are among the many expedients adopted by the Canadian settlers' wives for procuring comforts at a small cost, and working up materials that would, by the thrifty housewives of England, only be deemed fit for the rag-merchant. Let us see how a careful settler's wife will contrive out of worn-out garments—mere shreds and patches—to make a warm, durable, and very respectable covering for the floor of her log-parlour, staircase, and bedroom. "I asked the wife of the resident minister of P. what she was going to do with a basket of faded, ragged clothes, old red flannel shirts, and pieces of all sorts and sizes, some old, some new, some linen and cotton, others woollen. 'I am going to tear and cut them up for making a rag-carpet,' she replied; 'they are not good enough to give away to any one.' I fancied she was going to sew the pieces like patch-work, and I thought it would make a poor carpet and last no time.

"'I will show you,' she said, 'what I am going to do with these things.' She then took a piece, and with the scissors began cutting it into long narrow strips, about a quarter of an inch wide, not wider; and, indeed, the narrower the strip the better. She did not cut quite through when she came to the end, but left just as much as would serve to hold it together with the next strip, turning the piece in her

hand, and making another cut; and so she went on cutting or tearing, till that piece was disposed of; she then proceeded to a second, having first wound up the long strip; if a break occurred she joined it with a needle and thread, by tacking it with a stitch or two. Sometimes she got a bit that would tear easily, and then she went on very quickly with her work. Instead of selecting her rags all of one shade for the ball, she would join all kinds of colours and materials. 'The more lively the contrast the better the carpet would look,' she said. Some persons, however, wind all the different colours separately, in large balls, and then the carpet will be striped. A white and red ball wound together makes a pretty chain pattern, through dark stripes.

"My friend continued to cut and tear, join the strips and wind up, till she had a ball as big as a baby's head; and I continued to watch her, still puzzling my brains to think how these big balls could be turned into a carpet, till she lightened my darkness, by telling me that these balls, when there was a sufficient weight of them, were sent to the weavers with so much cotton-warp, which should be doubled and twisted on the spinning-wheel.

"If you double and twist the warp yourself, the weaver will charge 6*d.* a yard for the weaving, but if he doubles and twists he charges 8*d.* A pound and a half of rags will make one yard of carpet with the warp. Many persons dye the warp themselves: lye of wood ashes, with a little copperas, makes a deep yellow; logwood and copperas make a black; and indigo and lye from the house give a pale blue. Made

up with the coloured warp, the carpet looks better, and does not get dirty so soon.

"The white cotton rags are better washed clean and then dyed with any of these dyes. Those who do not care to take this trouble, use them as they are; but they soil soon. The best sort of rag-carpet is made by intermitting the colours as much as possible, cutting the strips through instead of turning the corners; you have more work in joining, but the effect is better; and there are no unsightly ends on the surface of the carpet. Bits of bright red flannel, of blue, green, or pink; mousseline-de-laine, or stuffs of any bright colours; old shawls and handkerchiefs, and green baize, will give you a good long-enduring fabric that will last for eight or ten years, with care. Children can be taught to cut the rags and join and wind into balls ready for the weaving.

"To the more wealthy class this humble manufacture may seem a very contemptible affair; but it is not for the gay and luxurious that such things are suitable; though I have seen them in the houses of some of the best settlers who were wise enough, like the wife of the rector, to value whatever was comfortable and saved buying. When well assorted, I assure you, these rag-carpets make by no means a despicable appearance on the rough floors of a Canadian farmer's house. I would recommend the settler's wife to keep a basket or box, into which all scraps of woollen and cotton, and any worn-out clothes, can be put. A rainy day may be chosen for the cutting and winding. Another box may be appropriated for the reception of the balls when wound up. The thinnest cottons, and even

muslins, can be used for the purpose; only that the latter articles may be cut half an inch wide.

"To wash a rag-carpet, let it be ripped into breadths, and taken to a creek or river, and flounced up and down, and then laid out to dry; no rinsing is required; the edges should be well bound with a broad strip of cloth. Thirty pounds of rags will make about twenty yards of carpeting; and when you consider that you can buy no sort of carpet worth making up under 4*s*. a yard in any of the country stores, this simple substitute, made out of refuse materials, is not to be despised."

An article on Yorkshire, in a number of the *Westminster Review*, gives a brief definition of Shoddy. It says:

"Not the least important of the manufacturing towns is Batley, *the chief seat of that great latter-day staple of England*—SHODDY. This is the famous rag-capital, the tatter metropolis, whither every beggar in Europe sends his cast-off gentility of moth-eaten coats, frowzy jackets, worn-out linen, offensive cotton, and old worsted stockings—this is their last destination. Reduced to filament and greasy pulp, by mighty tooth-cylinders, the much-vexed fabrics re-enter life in the most brilliant forms—from solid pilot cloth to silky mohair and glossiest tweed. Thus the tail-coat rejected by the Irish peasant—the gaberdine too foul for the Polish beggar—are turned again to shiny uses: re-appearing, it may be, in the lustrous paletot of the sporting dandy, the delicate riding-habit of the Belgravian *belle*, or the sad sleek garment of her confessor. Such, oh reader, is 'shoddy!'"

In the woollen manufacture a considerable portion

of the raw material is scattered as waste; but there are a number of "waste merchants" in different parts of the country who buy up everything like wool, and send it to Leeds, Dewsbury, and Batley, to be made into shoddy or mungo. Being mixed with some new wool, it is spun into yarn, and made into broadcloth, doeskins, pilot cloths, druggets, and coarse carpeting. The reproduction of a woven fabric from material formerly regarded as entirely waste and useless for such purposes, is a striking illustration of the adaptive ingenuity of the present day.

Besides the woollen rags collected at home, others are imported. These are torn up by machinery, and their fibrous material entirely separated; it is then spun into "low numbers," and made into a coarse description of woollen cloth, used for baize, table-covers, &c.

The rag-grinder takes the cloth, when thrown aside by the wearer, cuts it into particles, which he forcibly tears asunder, and thus re-models them into raw material, to be again used by the first consumer. And of such consequence is this last process to the trade, that the sixteen rag-machines in the town of Leeds alone are capable, in full work, of producing 3,605,760 lb. of raw material in a year; or, upon the average of 7 lb. to the fleece, of adding to the annual stock of wool the fleeces of 521,000 sheep.

In a visit to the districts of Yorkshire you will discover that pilot cloth is shoddy; that glossy beavers and silky-looking mohairs are shoddy; that the Petershams, so largely exported to the United States, are shoddy; that the soft, delicate cloths in which ladies feel so comfortable, and look so graceful,

are shoddy; that the "fabric" of Talmas, Raglans, and paletots, and of other garments in which fine gentlemen go to the Derby, or to the Royal Academy Exhibition, or to the evening services in St. Paul's and Westminster Abbey, are shoddy. And if Germany sends us abundance of rags, we send to Germany enormous quantities of manufactured shoddy in return. The best quality made at Batley is worth 10*s.* a yard; the commonest not more than 1*s.*

The first use of shoddy appears to have taken place about the year 1813. It is uncertain who first produced rag-wool, or shoddy, but the presumption is in favour of Mr. Benjamin Law. Brighouse may claim the merit of having had one or two of these rag-machines in work as soon perhaps as any place in Yorkshire. These machines were intended, in the first instance, not for the purpose of producing shoddy, but to grind thrumbs, hard bits of worsted waste, and such-like stuff. It is an ascertained fact that rag-machines were in use in London prior to their being so in Yorkshire, and that they were employed in making flocks from rags for saddlery and upholstery purposes. Probably the idea of grinding woollen rags was derived from the practice of grinding linen and cotton rags for, or in the manufacture of, paper.

A very interesting history of the shoddy trade, by Mr. Samuel Jubb, of the firm of Jubb & Son, Batley, furnishes some curious particulars respecting this now important manufacture, from which, by permission of the author, I shall draw some information.

The principal part of a rag-machine is the swift or revolving cylinder, set with iron-toothed plates,

somewhat like doffing-plates. One of these swifts contains from ten to fourteen thousand teeth, according as it is coarse or fine; the coarser-set swifts are used to grind soft rags, viz., stockings, flannels, carpets, &c., into shoddy; the finer-set ones, to tear cloth rags into mungo: these swifts perform six or seven hundred revolutions per minute, and would travel, if running over the ground in a straight line, at the rate of eighty or ninety miles per hour; it is, in fact, the rapidity of the swift's motion which is the primary cause of its effectiveness. The produce of a machine, formerly, was small, being only about one-fourth of the produce of one now; whilst the work was not done so effectively, and the price of it was threefold what it is at the present time. Machines now engaged in grinding soft rags, produce four or five packs of shoddy, and those engaged upon hard or cloth rags, two to two-and-a-half packs of mungo per day. The machine when operating upon soft rags, particularly the lower descriptions, makes its presence felt, by "kicking up a dust," which is by no means pleasant to those who are obliged to keep company with it. The occupation is not to be termed an unhealthy one; though, in the case of some few persons, it would appear to have induced asthma; and the very nature of the employment suggests this to be the ailment most likely to arise from it. To the uninitiated, it must be surprising to see the rags suddenly transformed in fibrous wool; and it is in this process of grinding that the apparent impossibility of making old rags into new cloth vanishes away: for those persons who are otherwise unable to form an idea how

the rag is to be metamorphosed into cloth, can, when it is assimilated to wool in its form and condition, at once see the solution of the supposed difficulty.

We proceed to furnish some calculations, made in 1858, respecting the quantity of rag-wool then being produced, together with the weight of rags required for the same. According to these, it is computed that at that time there were fifty rag-machines in the township, producing yearly about 13,000,000 lb. weight of shoddy and mungo, the latter estimated at one-third of the whole : this may be so as regards this locality (Batley), but, taking an average of all the rag-machines at work in the district, which includes Ossett, the proportion of mungo produced is probably from one-third to one-half the aggregate quantity. The following figures present the details of the calculations :—

| | |
|---:|---|
| 50 | machines. |
| 4 | packs of rag-wool, daily average of production |
| 200 | packs. |
| 6 | days per week. |
| 1200 | |
| 50 | weeks per year, allowing two weeks for holidays and repairs. |
| 60000 | |
| 240 | reduce into lbs. |
| 2400000 | |
| 120000 | |
| 14400000 | |
| 1440000 | deduct 10 per cent. for slack times. |
| 12960000 | net produce of rag-wool. |
| 4320000 | add 25 per cent. for waste of rags in grinding and picking. |
| 17,280,000 | lb., or 7,764 tons of rags. |

Assuming the foregoing table to be correct, it shows the large quantity of 7,764 tons of rags, converted annually in this township into rag-wool, the produce being 12,960,000 lb., or 5,785 tons. In the calculations referred to, it was assumed, that within a radius of four miles of Batley the quantity of rag-wool produced is equal to that at Batley itself; and furthermore, that all the scattered places in the woollen districts, lying beyond the radius in question, produce equally with Batley, or one-third of the total quantity manufactured in the country. According to this assumption, there is the enormous weight of 51,840,000 lb., or 23,143 tons of rags worked up yearly, in the shoddy centre and districts of the kingdom, yielding 38,880,000 lb., or 17,357 tons of rag-wool. Calculating the value of this material, shoddy at an average of 4*d.*, and mungo likewise at 6*d.* per lb., and reckoning the latter staple to constitute a third part of the whole, we find the entire quantity to amount to upwards of three-quarters of a million of money; the items of the account stand thus:—

| | |
|---|---|
| 25,920,000 lb. of shoddy, at 4*d.* per lb. | £432,000 |
| 12,960,000 lb. of mungo, at 6*d.* per lb. | 324,000 |
| Total .. .. | £756,000 |

This sum may be deemed expressive of the utility of the great rag and shoddy laboratory; the greater part of it represents what has been paid for labour, the value of the uncollected rag being less than half its final cost. We see, in the case before us, the principles of economy forcibly and pleasingly illustrated in practice; and materials regarded at one time as almost

worthless, converted, by the improving processes of manual labour and machinery, into valuable elements of textile manufactures. The seams, or refuse of rags, are used, after lying to rot, for the purpose of manuring arable land, particularly the hop-grounds of Kent and adjacent counties; and are also made into flock partially, for bedding and stuffing uses; they are, moreover—which seems strange indeed—manufactured into a chemical substance, viz., prussiate of potash, a valuable agent in dyeing. Shoddy dust, too, which is the dirt emitted from rags and shoddy in their processes, is useful in tillage, in like manner with the waste which falls under scribbling-engines; the latter is saturated with oil, in which consists mainly the fertilizing property. Waste is of more value than dust, even for farming purposes, the former having been generally about double the price of the latter; but dust has of late increased in value, so as to be well-nigh equal to waste. A large quantity of these materials is annually sent from Yorkshire into Kent, and other counties, to fertilize the soil. Recently, a plan has been hit upon of expressing the oil from the greasy waste; the oil so expressed, however, is thick, dark coloured, and rather disagreeable in smell; still, no doubt, the result, practically, is a benefit to the community. Shoddy dust is useful in other respects than for manure; it is now even carefully preserved in separate colours, and applied in the manufacture of flock paper-hangings, which are the best description of this article. Not a single thing belonging to the rag and shoddy system is valueless, or useless; there are no accumulations of mountains of *débris* to take up

room, or disfigure the landscape ; all—good, bad, and indifferent—pass on, and are beneficially appropriated.

In addition to the specified quantity of home-made rag-wool, there is a large importation of foreign constantly going on ; the weight of shoddy and mungo imported is estimated roughly to amount to 10,000 tons yearly ; probably three-fourths of this arrives at the port of Hull, and nearly the whole finds its way into the immediate locality of Batley, Leeds, &c. These imports are supplied by the Continent of Europe, and almost entirely, or at least the great bulk, by Germany and Denmark: in the latter country, manufactories for the production of rag-wool have existed for a length of time, a period of full thirty years, and the Danes have long been noted for their excellent qualities thereof. The manufacture of this commodity on the Continent has, like our own, increased gradually and largely, and has there spread itself over a wide space of territory—a space embracing several Governments, by whom it is fostered and encouraged. At Berlin there is a number of manufactories of rag-wool, several of which have been established by enterprising Dewsbury and Batley people : these factories produce both shoddy and mungo, and appear to be successful undertakings. The principal reason why our countrymen prosecute this business at Berlin and other places in Prussia, is, because that Government levies a heavy duty on the exportation of rags, and permits shoddy to go out free, thus affording facilities for an export trade in rag-wool not extended to rags.

France, Belgium, Switzerland, Norway, Sweden, Austria, and Holland, are the other parts of the Continent, not previously named, which contribute a portion to our imports of rag-wool. France, though possessing a vast population, has hitherto supplied this country with only an inconsiderable quantity of rag-wool; the French have done little themselves to raise a supply, and the efforts of our countrymen to do so, on French soil, have been, apparently, not very successful. As to rags, we have not been able to import any from France, on account of their having been prohibited as an article of export; but according to the Treaty of Commerce, lately concluded between France and England, the former has engaged to remove the prohibition, but reserves the privilege of imposing a heavy duty on rags shipped thence to this country. The amount of duty has not been fixed yet, we believe, but there are fears, on our part, that it will be such as to preclude either paper or woollen rags being brought over, to any material extent. It is interesting to note that our German neighbours applied themselves to the rag and shoddy business, so soon after its initiation in this country.

There is, we have reason to believe, very little shoddy or mungo used in the manufacture of cloth on the Continent; thus the staple of rag-wool, produced in foreign parts, like those of the important staples of cotton, wool, flax, &c., chiefly converges to one focus, viz., the "workshop of the world." Foreign rag-wool was subject to an import duty of a halfpenny per pound up to the year 1844, when it was abolished.

Superadded to the home-made and foreign rag-wool, is the quantity of extracted wool which is now being produced. "Extracting" is a new feature in the shoddy trade, and one of an ingenious and economical character. A few years, perhaps not more than five or six, have elapsed since the discovery of the process, which consists in extracting or separating the woollen portion from fabrics composed of cotton warp, and worsted or woollen weft. The principle of the process is to destroy the cotton chemically, and at the same time to leave the woollen uninjured; and this may be said to be literally accomplished. The raw materials used or operated upon in the manufacture or production of extract, are the tabs of stuff goods, in their varieties of worsted, alpaca, and mohair makes; cast-off dresses, or garments of the same materials; worn-out carpets, &c., all union make. These materials are of little value in themselves, but when subjected to skill and labour, yield a staple of wool or woollen fibre adapted to, and valuable in, the manufacture of certain descriptions of cloth. There has been a prejudice against the use of extracts, on the part of manufacturers generally hereabouts, and probably elsewhere too, thus preventing a more extensive application of the article at home; a prejudice, we said, but we think this hardly a fair way of putting the case; we ought, perhaps, rather to have stated there is a prevalent, and probably, therefore, a pretty correct opinion, that "extract" does not possess good felting properties, and that in consequence it has not found favour with the manufacturers in such a degree as it otherwise would. For some purposes, the real

or supposed lack of felting property in "extract" is no drawback, but rather an encouragement to its use, because it is mixed up with materials which require to be tempered by something less keen in the milling process; the broad fact is, that "extract," though excellent in its way, is not generally applicable in the shoddy manufacture, in like manner with shoddy and mungo. It would appear that foreigners have found out the adaptability of "extract" better than we have, for the greater part of what is produced is exported chiefly to the Continent. America, however, is a respectable customer in this line.

It is not possible to furnish an estimate of the total weight of this new species of wool now being prepared for the market periodically; the factories engaged in this business are located in various parts of the country, particularly southwards, and so far it has not concentrated itself conspicuously at any given place; we think it probable, however, that the largest quantity of extract produced in any town or city is in London. There is a mill at Batley busily engaged in the trade, which prepares, we understand, something like 10,000 lb. of the wool weekly. The principle of extracting has been only successfully applied hitherto, we believe, to rags containing a fibre of length and strength, so to speak, viz., a combed wool and worsted-made fibre. There can be no doubt that fine union cloth rags have been submitted to the process; but as no wool of the kind which would result, if the operation answered, has appeared in the market, it may be concluded the principle has not been found applicable to that description of rags; it is, however, a desideratum to

extract the woollen portion from union cloths, if the purpose can be effected without impairing the soundness of the fibre, and this because there is a large quantity of union cloth rags to be collected, of little worth now, but which would immediately become a source of wealth, in the event of the successful application of the extracting process to them.

The shoddy and rag merchants fall, continues Mr. Jubb, now under review: they form an important body, both as regards the number of them, and the extent of their transactions. Formerly, rag-dealing was not a distinct business, neither was the dealing in shoddy: it was the practice of the manufacturers in this locality to buy and sort the rags they required, and to grind them into shoddy also; but in course of time (say about thirty years ago) there arose a class of tradesmen who made it their business to supply manufacturers (chiefly out of the town), particularly those in the localities of Halifax and Huddersfield, with shoddies, which were then coming into use rather extensively in those districts: from that time to the present, shoddy dealers have multiplied in number, and increased in importance, extending their empire both at home and abroad. They now supply the manufacturers in this neighbourhood with a greater proportion of what these use than was the case formerly, whilst their operations, in relation to the outside shoddy districts, are on a greatly enlarged scale. These shoddy dealers probably set out with the notion that they could assort on their own premises all the rags required for the shoddy (exclusive of

foreign) which they could dispose of; but presently their trade increased beyond their capacity to do so, hence arose the class of "rag-dealers," or "rag-sorters," whose business is that of preparing rags for the cloth manufacturers and the shoddy dealers. From the date of their origin to the present, the rag-sorters have steadily increased, and since the introduction of mungo, in a greater ratio than before, so that now rag-warehouses present themselves in every part of the town. It is computed that upwards of eighty firms and individual tradesmen are engaged in the preparation and sale of rags, shoddy, and mungo, in the township of Batley; they are estimated to employ upwards of 600 hands, viz.:—500 pickers (females), 40 foremen over them, 80 rag-grinders, and 10 carriers. It is presumed the total number of rag-grinders will not be less than 130, of which we have allotted 80 to the shoddy dealers, the other 50 we take as connected with the cloth manufacturers, who supply themselves partially with shoddy and mungo from the rags. The principle of the subdivision of labour is being applied more and more every day. Rag-sorting is quite a different affair to what it was a few years ago; the rags are now classified into such a variety of colours and qualities that they yield a great number of distinct sorts—mixed softs, it is said, being assorted by some dealers into upwards of twenty different kinds: this method is highly conducive to the convenience of the clothier, as it enables him all the better to hit off exactly the colours and qualities required in his goods. What are termed soft rags, such as stockings, flannels, carpets, &c., predominate in weight

according to the tenor of the preceding calculations; but mungo from cloth rags either is, or appears to be, fast becoming a more important article than shoddy: it is more progressive, insinuating itself into the very seats of the fine cloth manufacture. Mungo has rapidly increased in use in the fancy and fine cloth districts of Yorkshire within the last few years, so that the production and sale of this valuable staple is an important and interesting branch of trade. The utility of mungo, or fine ground cloth, in the manufacture of woollen goods, was discovered about the year 1834, before which time the raw material was almost thrown away as useless, suffered to rot for tillage, or, at best, used for flock. Mungo was first brought out at Batley, and soon became appreciated as a useful auxiliary to the local trade. The discovery of mungo forms a remarkable era in the history of the shoddy manufacture, and has led to the most beneficial consequences to the trade of the district. Mungo now constitutes the principal raw material which enters into the composition of the goods made here (wool excepted), and occupies a leading position as a constituent of pilots, which are the staple cloth produced, and it is also used in a variety of goods. The name of the article in question, viz., "mungo," may appear a very odd one to persons not accustomed to it, for though the term is understood in the trade, it appears very unmeaning, and to have no necessary or natural affinity with the commodity designated. The origin of the term "mungo" is said to be this—one of the dealers in the newly-discovered material was pushing the sale of a small quantity, when doubts were expressed as to

its likelihood to sell, to which the possessor replied, with emphasis, "It mun go," meaning it must go. Mungo is largely produced on the continent of Europe; some of the makes or qualities, sent out by certain parties, are excellent, both as regards colour, condition, evenness of fibre, and general character. These makes are superior to the run of the qualities got up in this country, and are evidently the result of skill and painstaking labour. A considerable, if not the chief portion of the imported mungo is sold by auction to the manufacturers and dealers, now at Dewsbury, but until lately at the Dewsbury and Batley stations on the London and North-Western line of railway. Mungo rags are derived from a wide range of places—London, the provincial towns of England, from Scotland, Ireland, many parts of Europe, America, and Australia. America has, of late, contributed this commodity somewhat largely to the supply of the market here; the mungo rags thence are in the highest esteem with buyers, and are preferred to those from London, which in a general way may be said to stand next to American in point of value. London furnishes by far the largest quantity, not only on account of its vast population, but because it is the point to which country collections converge, within a certain radius. Mungo rag is either old or new,—the old being such cloth as has been made into garments and worn; the new, tailors' shreds or clippings from new cloth. It is the general practice, more especially in London, to keep the two sorts distinct; the new, though a smaller rag than the old, is of more value in the market by about 1½*d.* per lb.; the old

mungo rag is cut from coats, vests, trowsers, caps, &c., which, before passing the shears or being seamed, are termed "water-flock." The women in London employed in this operation of seaming are very expert at their work. Mungo fluctuates in value to a greater extent than shoddy; the rag, now at a high price, is about four-fold what it was at one period, in the early days of its history; the price of London mungo rag (old) then was £9 or £10 per ton, whereas at present it is about £38 per ton; in the interval, the intermediate prices have been touched; the highest value this article has ever reached is £42 or £43 per ton. The great permanent increase in the value of mungo-rag, and the brisk and extensive demand for it, sufficiently attest the esteem in which it is held. The sources from which soft rags are derived are substantially the same as those from which mungo rags are received. London is the great entrepôt for soft rags; but it must be noted that America, whilst contributing freely mungo-rag, sends us little, if any, of the soft kind. It is presumable that the whole civilized world is engaged, either directly or indirectly, in supplying this country with linen and woollen rags, or the produce of the latter; if not now, such will, no doubt, be the case shortly, for the field of operation in this respect is apparently ever enlarging. London serves the market with mixed softs, stockings, white flannels, stuffs, carpets, &c., in addition to the large quantity of army cuttings produced there, viz., serge, flannel, and cloth clippings of various colours and qualities; these constitute a valuable part of the rag collection, being new, sound, and of good colour and quality. Scotland

sends her stockings and mixed rags; Ireland, her whites; Germany, her knitted stockings, in grey and white, and also what are termed "nons;" Austria and Italy also swell the general stock, by their quotas of soft and mungo rags; Turkey and Russia also furnish low coarse softs.

We shall now refer to the shoddy sales by public auction, which have taken root as an institution in connection with the shoddy trade: these were commenced some eight or ten years ago systematically, and have been continued with commendable regularity. The sales had been held from the first at the Dewsbury and Batley Railway stations, chiefly at the latter, until recently, and they are now conducted at Dewsbury, on the premises of the respective auctioneers, rooms being assigned properly adapted to the purpose: this method is, in some respects, an improvement upon the previous plan, being, at any rate, conducive to the physical comfort of buyer and seller. There are usually two sales per week, which are conducted alternately, on different days, by the two auctioneers through whose hands the bulk of shoddy and mungo sold publicly passes. The quantity falling under the hammer weekly may be fairly estimated at 60,000 or 70,000 lb., comprising a range of all qualities and colours, varying in price from under one penny to upwards of one shilling per pound; in addition, wool, hair, waste, and rags are sold. These sales have attained considerable importance, and are attended by parties interested from all the manufacturing districts around.

It may not be uninteresting to insert here a

notice of the trade, and of one of these shoddy sales at the railway station, by a gentleman—a mere observer,—which appeared in a local paper, showing, as it does, the impressions made upon his mind by the active and novel scene before him. The article is headed "The Batley Rag and Shoddy Sales," and runs thus:—

"We know not who first discovered that woollen rags, if pulled to pieces, ground, and then mixed with wool, would greatly reduce the cost of the lower kinds of woollen fabrics. The name of the scheming genius who originated the happy idea may, perhaps, never be satisfactorily settled, and, therefore, never receive the fame to which it is entitled; but the results of the discovery are highly important, and are among the most wonderful developments of modern industry. Whether Batley can justly claim the honour of having given birth to the pioneer of the great 'rag and shoddy' trade we have never been able to ascertain, but it is certain that Batley had taken the lead in it, and has now completely distanced all competitors. Certain difficulties with which Dewsbury had to contend, in regard to railway arrangements, have chiefly contributed to this result, and Batley is now unquestionably the head-quarters of the shoddy trade. What the cotton trade has been to the towns of Lancashire, the rag trade has been to Batley—a source of wealth and remunerative employment. Between twenty and thirty years ago, Batley was a considerable village; but certainly insignificant in comparison with what it is at present. So recently as 1841, the population was only about 7,000: in 1857, it had increased to 12,000; a rate of increase not often witnessed in

English towns. Instead of a dull, jog-trot village, we have a busy, enterprising town. Large mills and warehouses have sprung up with extraordinary rapidity, new streets of dwelling-houses have kept pace with them, and other improvements, which we need not now enumerate, have succeeded, until Batley, at this moment, possesses almost all the characteristics of an important manufacturing town. For this prosperity it is indebted to the rag and shoddy trade—such virtue is there in 'old clothes.' About a dozen years ago, the extensive demand for woollen rags, and the great expense and inconvenience of purchasing them in London, Hull, and other towns, led to the establishment of public auction sales at Dewsbury, Batley, and, we believe, Thornhill Lees. But owing to the difficulty of getting the goods to Dewsbury, in consequence of some arrangements between the two railway companies, whose lines are near that town, Batley, during the last six or seven years, has been selected as the depôt for rags and shoddy, and there we have now regular sales on a precisely similar plan to the London colonial wool sales. At the commencement, the number of bales offered was not very large, nor was the attendance of buyers numerous; but the advantages of the plan were soon appreciated by all concerned, and now, hundreds of bales, amounting in value to many thousand pounds, are offered for public competition every week. Mr. Cullingworth, Mr. Pearson, and Mr. Rydill, of Dewsbury, are the auctioneers, who so arrange the days of sale as not to interfere with each other's sales. Recently we resolved to gratify our curiosity by attending to watch the proceedings. On our arrival at the

Batley station, we were struck with the vast quantity of rags, shoddy, and mungo, heaped up on every hand. A large goods warehouse and a long shed were both filled with heavy bales. A considerable number of railway trucks were piled up with them, and a great number were also 'stacked' on the ground, and covered with tarpaulin, evidencing the great extent of the trade. We were informed that the great bulk of the rags were from the Continent, being brought from Berlin, Rotterdam, and other Continental depôts, by way of Hull. After a hasty glance at the shoddy stores, our attention was first arrested by two foreigners (Germans), who were busy inspecting the bales intended for the day's sale. These, we were informed, were persons who had made consignments of rags, &c., and who were come to look after their disposal. Several men, in long check pinafores, completely enveloping the body and reaching to the heels, were lounging carelessly about, as though the result of the sale were to them a matter of perfect indifference. While the intending sellers and buyers were anxiously speculating on the amount of profit to be realized from these large somewhat dirty-looking bales, and visions of filthy rags being transmitted into shining gold rose up before them, the pinafored gentlemen were evidently at their ease, their thoughts scarcely belonging to the scene before them. They were accustomed to it, and a bag of shoddy had no peculiar charms. It

> A bag of shoddy was to them,
> And it was nothing more.

On conversing with one or two of them, however, we

were much pleased with their shrewdness and intelligence. In marked contrast with the indifference of these men was the interest manifested by intending purchasers, who were scattered about singly and in small groups. Some were seated on the bales on the ground, others were perched aloft on the highest truck; and as they thrust their hands into the bales, bringing out some extraordinary good or some exceedingly bad sample, a note was made in the catalogue or note-book, to guide them in the coming sale; and the self-complacent smile told plainly enough that, while they were not to be done, they were quite ready to seize any good bargain that might offer itself. Although scarcely a word was spoken, it was evident enough that they knew a good deal more than the catalogues told them about the rags, &c., before them, and that such knowledge would be fully exercised during the sale. There were from fifty to sixty of this class present. They were chiefly plainly-dressed men, manifestly having no time or inclination to study the latest fashions; but they were a shrewd-looking, hard-headed lot: and the success which has rewarded their exertions in their peculiar trade, shows them to be of the true English stamp of tradesmen. Plain and homely as was their exterior, they were ready to pay down sums of money which would astonish those accustomed to associate wealth with fine clothes. Those somewhat dusty and greasy coats belonged to men of substance, and who, had you traced them home, you would have seen, prided themselves, like Dogberry, on 'having everything handsome about them.' Most, if not all of them, were originally

men of small capital, and their present position is mainly owing to their indomitable Saxon industry and perseverance. In the early stages of the rag and shoddy trade, the calling of a rag-merchant was scarcely considered 'respectable,' and men of capital and 'standing' held aloof. This left it in the hands of the small capitalists, and well did they use their opportunity. Now, we are informed, the profits are not so large as they were, there being more competition, and the mysteries of the business having become more generally known. About the time announced for the commencement of the sale, Mr. Cullingworth, the auctioneer, accompanied by his assistants, drove up, and then making his way to the lot intended to be sold first, he mounted upon the bale and stated what the lot was, referring purchasers to their catalogues. A circle of spirited bidders was soon formed around him, and in a short time — between two and three hours—there were sold fourteen tons of rags, &c., and three hundred bales of mungo. The sale was conducted in the most orderly manner. No time was wasted, and the only disturbance experienced arose from the shunting of railway trucks, some of them laden with huge blocks of stone, upon the sale-ground. Several times was the company disturbed by the cry, 'Mind the waggons,' and immediately an engine and trucks thundering past told pretty plainly the warning had been far from unnecessary. We thought the practice of shunting waggons on the sale-ground, during sale hours, a rather dangerous one, but as no accidents have ever occurred—so, at least, we were informed—we suppose people are reconciled to it."

Having disposed in the main of the subject of rags and shoddy, as raw materials in the shoddy cloth manufacture, we must now devote attention to the manufacture itself, and give, at least, a general outline of its character and economy, and though some of the details may be considered dry, it is hoped that the exposition, as a whole, will not be uninteresting. Various are the descriptions of cloths produced, and wide their range of value: they are sold in all markets, consumed in all countries, and serve alike to adorn royalty and to clothe the crouching slave. The principal article in plain, mixed, and fancy styles, is pilot cloth. Flushings, druggets, and paddings were the goods chiefly produced in the early period of the trade. A cloth which may be classed under the head of flushings or low duffels, and popularly known by the name of "short-ends," was largely made for a series of years, but ceased to be required about twenty years ago, at least in the same order of arrangement: a cloth called calmucks, of a similar kind as near as may be, has, it would appear, replaced "short-ends," but in a diminishing ratio. Short-ends were sold to the merchants, principally those of Leeds, in the grey raised (not balk) state, and charged by the pound. These goods were for the Continental market, and were dyed and finished by the merchant before being despatched thither. As is commonly the case with any description of cloth which runs out, as it is termed, so with this of "short-ends," the quality and excellence were depressed lower and lower, until the "short-ends" of the period of their extinction as such were very inferior to those of primitive production.

Flushings, which are a heavy, coarse, well-raised cloth, were formerly much in request, forming, in fact, a leading article in the trade : they have very little finish on them, and probably pilot cloth, which is much neater, has superseded them in a material degree. Flushings have been principally taken in blue and drab, and in substance varying from $1\frac{1}{2}$ to 3 lb. the yard, 54 inches wide ; price from about 1*s.* 6*d.* to 5*s.* or 6*s.* per yard. This class of goods is still made, but not largely, except occasionally for her Majesty's navy, which, especially in war times, requires heavy supplies in a good quality.

Druggets were a mixed unraised cloth, and frequently plaided, of which a considerable quantity was manufactured in various qualities and widths, from about 1*s.* 6*d.* to 3*s.* or 4*s.* per yard. This cloth was chiefly made at Batley Carr, where a little continues to be produced. Its principal use has been for low carpeting, and to cover and underlie, for the sake of protection, carpets of a superior description. Druggets were mainly confined to the home market, the greatest number being sent to London, many to Manchester, and some to Ireland and Scotland. It is difficult to say why this class of cloth, with which padding cloth may be identified, has fallen off so much in the demand, unless it be that felt cloth has superseded its use. Drugget cloth (a great deal of it at least) was of a low character, and could not well be made lower, so that either felt cloth or some other, probably a more suitable one, has been substituted.

Red and crimson paddings (unraised piece-dyed cloth) were made in quantity contemporaneously

with drugget cloth, and for much the same purpose, though a greater proportion would be used of the former than of the latter, for stuffing and stiffening coat collars, &c. ; and it is likely that padding cloth in those showy colours was used for table-covers, printed and unprinted, and other drapery. Paddings, like druggets, were made in various widths,—viz., from six to twelve quarters broad : in point of character and value, paddings were the better article of the two. Olive padding cloth must not be omitted, being a low article formerly made to some extent, and used chiefly for stuffing coat collars, &c. The markets for padding were identical with those for drugget cloth, except as regards a very low species of narrow red cloth, which has been and continues to be produced in the vicinity of Huddersfield and Halifax, and which is chiefly exported.

Shoddy goods of a different stamp to each other, and varying materially either in quality, make, weight, colour, finish, or some other property, have been from time to time introduced to the market, so that quite a list of the names of the several cloths may be made out. It is almost impossible to give them all, but the more prominent are as follows :—

Flushings, druggets, paddings, duffels, short-ends—calmucks, Irish frieze cloth, Witneys, mohairs, pilots, Tweeds, Petershams, Strouds, save-list cloths, army goods, reversibles, linings, velvets, seal-skins, coloured blankets, union and prison cloths, Canadian cloths, Cheviots.

Even the greasy cotton wads with which engineers wipe their machinery enter into the material of some

qualities of shoddy. But there are woollen rags that are not good enough for shoddy, and these are used, as we have seen, as manure for the hops in Kent, so that we get shoddy in our beer as well as in our broadcloth. Two lb. and a half of dry woollen rags, we are told, are equal to 100 lb. of farm-yard manure, or 15 lb. of liquid blood, when applied to land.

The flocks made at the "rusing gig" from pilot cloth in the wet state are cleaned and dyed, and used in the manufacture of certain yarns. These flocks are also used for stuffing mattresses, seamen's bedding, and common articles of furniture. There is still, however, some "mill waste" which cannot be worked up again for shoddy, namely, that portion of the wool waste which is so saturated with oil and grease, that the fatty matter is heavier than the wool. This is called "creash," and forms a very valuable manure.

A process is now in operation at the Kinghole woollen mills, near Dumfries, by which the hitherto refuse water of the washing-houses is converted into valuable commercial material. By means of mechanical appliances and chemical action, the refuse formerly turned into the river Nith, to the injury of the salmon, is made to produce stearine, which forms the basis of composite candles, as well as a cake manure that sells at 40*s.* per ton.

Teal's patent for recovering the fat from waste soap liquors is chiefly applicable to wool-scourers' soap-waste, and is conducted in the following manner :—

The fluid, as obtained from the wool-scourers, is run into large tanks, where it is heaped along with sulphuric acid, which causes the fat to separate from

the soap and rise to the surface, carrying with it all the impurities removed from the wool. The semi-solid product, after separation from the water, is, according to Professor Anderson, subjected to pressure in powerful Bramah presses, when the oil or grease is expressed, and a dark-brown cake, still containing some oil, along with small quantities of woollen fibre and other impurities, is left.

This refuse substance, which contains about 71 per cent. of organic matter and 3 per cent. of alkaline salts, is sold for manure. Glue-makers' refuse has long been employed as a fertilizer in the vicinity of tan and glue works, and with good success when applied to any kind of crop, as from its putridity it acts rapidly. It is worth about 36*s.* per ton.

Poake, a name among fellmongers for the collected waste arising in the preparation of skins, which consists of lime, oil, and hair, in various proportions, is also bought for manure.

Wool, ground very fine and dyed, is now extensively used in the manufacture of flock-paper hangings. The wool that comes off the sheep-skins, after soaking in the lime-water of the tan-pits, is sold, when washed, at 3*d.* to 5*d.* the pound. We imported in 1861, 8,000 tons of woollen rags, valued at £250,000; and flocks and flock for paper-stainers to the extent of 6,195 cwt., of the further value of £11,248.

In the carpet manufactories, the waste from the carpet looms is used for stuffing mattresses, &c.; another portion of the waste from the looms and winder-wheels is used for making prussiate of potash, and the general mill-waste for manure.

There are many light articles of ladies' dress, such as balzarines, orleans, coburgs, alpacas, &c., which are formed by an admixture of a warp of cotton with a weft of worsted, or of mohair, alpaca, &c. Now, after these are worn out or thrown aside, they are comparatively valueless, from the mixture of the two substances, but, by a chemical process, which has been already alluded to, the cotton is now destroyed, and the wool, the most valuable substance of the two, recovered for future use in making woollen cloth.

Passing from the use of old woollen rags, on which, from its present importance, I have dwelt at some length, I now come to the application of a former waste substance which has grown into importance, namely :—

## COPROLITES.

Coprolites are the exuviæ of extinct animals, but in the commercial meaning the name also includes bones, teeth, and other fossil relics of animals. Containing much phosphate of lime, they are used for making superphosphates. When ground to powder in a mill, and acted on by sulphuric acid, a part of the phosphoric acid is liberated, and a more soluble compound obtained. But little is known on this subject, and no lengthened details have yet been published that we are aware of. It is chiefly in the counties of Cambridge and Suffolk that coprolite is obtained. The following particulars relate chiefly to Suffolk coprolites.

It is supposed that part of south-east Suffolk was once a large arm or estuary of the sea, wherein dwelt

the monsters of the deep, and that their organic remains have been buried up by some great convulsion of nature, most probably at the time of the Deluge. At the distance of ten miles from the present boundary of the sea, we find parts of land animals and vegetable remains; but what more likely than that the beasts of the forest should have preferred the margin of the water?—their bones, with trees, fruit, and seeds, all having been washed into the sea. That it was once the sea is sufficiently proved by the shells, and the great quantity of cement-stone we find, of exactly the same description dredged for on the coast. A still more convincing proof is the immense quantity of barnacles; in some knots each barnacle is as large as a walnut. Coprolite is a species of fossilized guano, most probably of the saurian, whale, shark, and other large animals. It looks like dark oblong pebbles, rounded and polished by the water; they are very brittle, and the interior is dullish brown, slightly tinged with yellow, but they emit no smell. Some of them contain small teeth and bones, which show that they belong to some carnivorous animal—bones and vegetable remains being comparatively rare. Coprolites were first discovered in a part of Suffolk about the year 1846. A celebrated artificial manure manufacturer was walking with a gentleman on Bawdsey beach, and picked some coprolites up that had been washed out of the crag cliffs. Finding it contained manuring properties, he requested this gentleman to employ children to pick it up. This continued about two years, when one day the children had picked some out of the cliffs so far under that the

crag slipped in and killed a little girl. At the inquest the jury wanted to know what coprolite was; the consequence was, that farmers discovered that their crag-pits were full of it, and some began to dig for it, selling it to the same gentleman at about £1 per ton.

The manufacturer had obtained a patent, but, it being infringed, he brought an action and lost it; and then every one was allowed to manufacture it into manure. It is very heavy, three pecks weighing about one cwt. The result was, it gradually rose in price to £3. 10*s*. This was an inducement for all to raise it. Fine crops of wheat were dug up, buildings were undermined, cottagers turned over their gardens, clergymen the churchyards, and surveyors the roads; some farmers employed over fifty men at it, and though numbers were imported, labourers' wages were raised fifty per cent. by it; and those who had no coprolite felt it severely, and some parts of the country had the appearance of the Australian gold-fields. Many made their fortunes, and others for years made the rents of their farms by it. The landlords claim a share, generally half the net profits, but the lord of the manor has no claim. It is generally found within two miles of the banks of either the Orwell or Deben rivers, and lies in beds from ten to five hundred yards in width, and from two to forty feet in depth. After digging through the top soil, we come to a light sand, and then to some white crag, which gradually becomes red; next a stratum of dark crag, interspersed with every variety of sea shell, under which, and above the loam, we find the vein of coprolites, from

six inches to thirty-six inches in thickness. It is found mixed with crag, cement-stone, shells, and water. In some cases there are two veins, with a stratum of crag between them; and at one place it is found in the sand just beneath the top soil. It is worked by digging a long trench about two yards wide, and when they have dug out the coprolites they dig another parallel, the earth from which fills up the old one, and so on in succession; as it lies next the loam, the water is very troublesome, and in most places has to be pumped out. After the coprolites are thrown out they sift away the crag, and when the soil sticks it has to be washed; it is then spread out on a table, and the shells and stones are picked out by children, after which it is weighed and generally conveyed by water to the manufactory; there it is ground up and pulverized with sulphuric acid. Coprolite is principally used for manure, and for adulterating guano, and the refuse is employed in the manufacture of fine ware, and some particular kind of paint. The cement-stone is used for building out-houses, and the loam for making bricks.

These extraordinary diggings have opened such a field for geologists and scientific men, as does not exist in any other part of the kingdom. The fossil remains are so numerous and rare that I shall not attempt to describe them, but merely state the principal things that are found. The remains of the whale and saurian are very numerous, also those of the shark and all kinds of fish; but the bones found of land animals, such as the mastodon, elephant, rhinoceros, deer, wild boar, and birds, are not so plentiful. Some of

the fossil shells are very rare, and there is a great variety of beautiful coral. We find several specimens of wood, all of which take a high polish, and enable you to distinguish the description. A large assortment of fruits and seeds, most of them very perfect, are also found.

The consumption of mineral phosphates, according to a recent estimate of Professor Anderson, of the University of Glasgow, is about as follows :—

| | Tons. |
|---|---|
| Cambridge coprolites .. .. .. | 40,000 |
| Suffolk coprolites .. .. .. | 3,000 |
| And all other mineral phosphates .. | 5,000 |
| | 48,000 |

which, being entirely converted into superphosphates, will yield 72,000 tons ; at £5 per ton value, £360,000. Coprolites ground to a fine powder, and containing 58 per cent. of phosphates, sell at £2 12*s.* per ton, and a ton of pure phosphates is consequently sold for £4 8*s.* In this state, however, the price is extremely low, because it is alleged that the phosphates are in so compact a condition that the plant cannot avail itself of them, and they are only used as a raw material for the manufacture of superphosphates.

## COMMERCIAL PRODUCTS OF THE PORPOISE.

An animal which, though once considered a royal-food delicacy, had long since passed into neglect, at least for the table, has lately been utilized again by man, and that is the Porpoise.

Porpoises are seen in droves, lifting and dipping their noses, not only over the whole Atlantic, but close in upon the American shore. They are very valuable on account of their oil, and their skin has lately been utilized; but no good plan to capture them has yet been discovered.

In Nova Scotia porpoise fishing is almost exclusively carried on by the native Indians, who display much patience and skill in this employment. Two of them enter a light bark canoe, and, even when the waves are running high, they will paddle out several miles from the shore. The foremost man is ever ready with his gun, and as the nose of the porpoise appears above the water he fires. The man at the stern then paddles with all his might to reach the animal, for if quite killed, it sinks immediately. If the shot were successful, the porpoise is carefully handed into one of the narrow ends of the canoe. As this animal only shows his head above water for an instant, the sportsman who shoots him has something to boast of. About 1,500 gallons of porpoise oil are annually collected at Digby Gut, in that province, by a party of Indians from Annapolis and Bear River.

The animal generally termed the porpoise is a species of whale—the northern beluga (*Beluga catodon* of Gray). Although occasionally seen in the Bay of Chaleur and parts of New Brunswick, it is in the river St. Lawrence that it is most common. This cetaceous animal became, after the discovery of Canada, an article of commerce which entitled the first colonists, who engaged in catching it, to a special protection on the part of the French Government.

In 1707, there were no less than eight companies, established at different points of the river, for carrying on this business, whom the Intendants protected by their edicts and ordinances; and their number, at this period, would alone be sufficient to prove the importance which this fishery might acquire. The oil of the porpoise was then worth only a franc a gallon, its skin was somehow considered of little value, but the facility with which it was taken was so great, that the quantity alone sufficed to make it sought after, and to render the pursuit profitable to those engaged in it, amongst whom a company of six *habitans*, at Rivière Ouelle Point, was particularly distinguished.

During the year 1710, this company took 800 porpoises. Some years later it killed thousands, but the numbers gradually diminished every year; and, whether from the more frequent navigation of the river proving a cause of alarm to this valuable fish, or from some of those hidden causes which the depths of ocean veil from us, they ceased to live together in large shoals, and dispersed into all parts of the river. It cannot, however, be said that they are now less numerous in the St. Lawrence than heretofore; on the contrary, their number is much greater, and their species belongs exclusively to this river. It is in a manner the king, as it is also the largest and most profitable of those which live permanently in the North American waters.

This animal was formerly taken in inclosures, made of light and flexible poles fixed in the beach, within which the porpoise pursued the small members of

the finny tribe during high tide, and where, when once his appetite was sated, he became heavy and almost asleep from gluttony, and seemed to forget, during several hours, the dangers which surrounded him as the tide went out. The fisherman, silent and on the look out upon the cliff, having seen that the waves had retreated, and were now breaking upon the rocks outside the inclosure, gave the signal : two or three light skiffs (either bark or wooden canoes), manned by three or four expert rowers, appeared upon the waves, which they scarcely touched with their oars. Standing in the bow of each of these canoes a man, with bare and muscular arm, a steel spear in hand, intently followed with his eye the track of the fish, indicating the course to be taken, whether to the right or left, and struck the mortal blows. Often, after one of these vigorous strokes, which were enough to kill the largest porpoise, the spearsman might be seen, when he did not strike aright, urging on the pursuit for a new contest of speed between his skiff and the wounded animal ; sometimes the blood which reddened the surface of the water indicated the course to be followed, and sometimes the sound of the subdued breathing of this cetacean, which comes to respire and throw off the air at the top of the water, spouting up a stream which descends in the form of a curve. The porpoise might break through the fence of flexible poles, eighteen or twenty inches apart, but he is afraid. As soon as he sees them, he returns by the way he came ; a new stroke is given, but it is by a harpoon, which has a light rope attached. The struggle is becoming more

intense and animating, and the fisherman smiles with satisfaction; the paddle at the stern of the frail skiff is alone put into requisition. It is now the turn for the boatman to display his skill. The animal leaps out of the water, stops, dives, and turns about in every way and in all directions; a white foam like that of a rapid rises on each side of the bows, and the progress of the canoe, hitherto so swift, suddenly stops; the animal is fatigued by his wound; he wants to breathe, but fear keeps him at the bottom of the water; and immediately the man in the bow rolls up at his knees the line which he had allowed to run out, he uses it to guide the direction of his barque, which light and soft strokes of the oar bring silently forward to the victim. Again he stands up, and with one hand brandishes his spear, while with the other he suddenly chucks the rope, thereby inflicting renewed pains; the fish once more leaps, but this time is the last, for a vigorous blow aimed at the spine, between the head and neck, has effectually done for it.

These chases sometimes last for whole hours, and there were instances of this kind in 1857 and 1858. One hundred and fifty-nine porpoises were taken during those two years, at Riviere Ouelle. Stakes are now used to make the enclosures only at Riviere Ouelle, St. Anne's, and Isle aux Condres. But, for some years past, another method has been adopted; and, no doubt, if it had been on a more extended scale it would have yielded immense profits.

Mr. Tetu, of Riviere Ouelle, so well known for his enterprising spirit, and by the distinguished con-

sideration which he has gained by his experiments in the capture of this animal, the clarifying of the oil, and the employment of its skin in the manufacture of a leather which has no equal, has, for several years past, in conjunction with other persons engaged in the same commendable pursuit, adopted the system of taking the porpoise in nets, near the river Saguenay.

Thanks to Mr. Tetu's experiments, the oil is worth 6*s.* a gallon, and the leather from 6*s.* to 10*s.* a pound. The oil is extremely ductile, inodorous, and gives a brilliant light, only surpassed by gas. It is superior to any other for the use of lighthouses, because it does not coagulate, even in the most intense cold, and its ductility renders it invaluable for greasing leather, and also machinery, which it preserves from injury by friction. Appreciated as such by the Great Exhibitions of Paris and London, of Canada and New York, it has gained Mr. Tetu testimonials which do honour to him as a useful citizen. Mr. E. B. Roberts, of Regent Street, furrier to the Hudson's Bay Company, has introduced porpoise leather into general use in this country.

The skin of this animal is of a tissue, the exact character of which it would be difficult to establish, when I have before me ten or twelve samples of different kinds of leather made from the same skin; in the normal state, kid, sole leather, harness leather, velvet leather, plush leather, black leather for foot gear, and varnished leather. The skins are dressed for traces, and the Canadian mail bags are usually made of them. These bags are very white, thick,

and soft; they stand much chafing, and effectually resist the wet.

Porpoise skins, when tanned, will compare favourably with the best French kid in beauty, cheapness, and durability. For a light shoe, the leather is equal to Morocco or any other made. To those troubled with corns or gouty feet, it is found a great comfort, in comparison with the stout cowhide mostly used. The tanned and prepared skins, and boots, &c., made from them, may be seen in the animal collection of the South Kensington Museum. The average price of a porpoise, considering the increasing value of its skin and oil, is 100 dollars. Its weight is about 2,500 lb.; the largest attain 4,000 lb., and are worth 180 dollars; these are about 22 feet long and 15 in circumference.

---

## PRUSSIATE OF POTASH.

It is one of the most important duties of manufacturing industry to find useful applications for waste materials. Dirt has been happily defined as only "matter in a wrong place;" and the object of this work has been to show the useful appliances of the most common objects. On this subject Dr. Lyon Playfair, in one of his lectures, says,—"Chemistry, like a prudent housewife, economises every scrap. The horse-shoe nails dropped in the streets during the daily traffic are carefully collected by her, and reappear in the form of swords and guns. The clippings of the travelling tinker are mixed with the parings of horses' hoofs from the smithy, or the cast-off

woollen garments of the poorest inhabitants of a sister isle, and soon afterwards, in the form of dyes of brightest blue, grace the dress of courtly dames. The main ingredient of the ink with which I now write was possibly once part of the broken hoop of an old beer-barrel. The bones of dead animals yield the chief constituent of lucifer-matches. The dregs of port wine, carefully rejected by the port-wine drinker in decanting his favourite beverage, are taken by him in the morning as Seidlitz powders to remove the effects of his debauch. The offal of the streets, and the washings of coal-gas, reappear carefully preserved in the lady's smelling-bottle, or are used by her to flavour blancmange for her friends. This economy of the chemistry of art is only in imitation of what we observe in the chemistry of nature. Animals live and die: their dead bodies, passing into putridity, escape into the atmosphere, whence plants again mould them into forms of organic life: and these plants actually consisting of a past generation of ancestors, form our present food."

We will suppose that we have a quantity of old woollen rags too bad to be used for any other purpose, and animal offal, such as comb-makers' shavings, pigs' toes, dried blood, &c. If we calcine these substances for a considerable time with pearlash, or carbonate of potash (which is the principal ingredient in the ash left by trees when burned), and some iron filings, in an egg-shaped iron pot, stirring it from time to time,—we shall obtain a mass, which, boiled with water, the insoluble impurities removed, and the liquid evaporated, will yield beautiful yellow crystals

of a substance known as *prussiate of potash.* It is best prepared as follows :—A mixture of potash or pearlash, as free as possible from sulphate of potash, with any cheap nitrogenized animal substance, such as horn waste, hoofs, tallow, waste, or "cracklings ;" woollen rags, dried blood, hair or leather cuttings, or, preferable, with any of these substances previously carbonized, is heated in a closed iron crucible to a high red heat ; the mass, after cooling, lixiviated with water, and this solution digested by a gentle heat, with iron filings or borings, until no more hydrogen gas is given off. The solution on evaporation and crystallization will give the yellow prussiate of potash, or ferrocyanide of potassium, as it is sometimes called. The theory of the composition and formation of this substance, as elucidated by the researches of Liebig, is so complex, that it must be omitted here. Yellow prussiate of potash crystallizes in large lemon-yellow tubular crystals, which belong to the dimetric system, and have an eminent basal cleavage. It has a sweetish, salt, and bitter taste, and is very poisonous. As it occurs in commerce, it is frequently falsified with carbonate of potash, which may be detected by means of turmeric paper, being perfectly neutral. It is used chiefly in the manufacture of prussian blue, and in dyeing. Of late years, it has also been largely used for the manufacture of cyanide of potassium, by the method of Liebig, for use in the new art, electro-plating with gold and silver. Nothing can illustrate more forcibly the advance of the arts of electro-plating, and other arts in which prussiate of potash is used, than the following table, showing the progress

of the manufacture of prussiate of potash in Great Britain, and the alterations in its price through a series of years. The annual production from

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | *s.* | *d.* | |
| 1825 to 1830 | about .. | 10 | tons, | at 5 | 0 | per lb. |
| 1830 to 1835 | ,, | 40 | ,, | at 2 | 6 | ,, |
| 1835 to 1840 | ,, | 200 | ,, | at 1 | 4 | ,, |
| 1840 to 1845 | ,, | 700 | ,, | at 1 | 4 | ,, |
| 1845 to 1850 | ,, | 1,040 | ,, | at 1 | 3 | ,, |

The annual production of this substance is now much larger, while the price has been still further reduced.

But what is the use of these yellow crystals? We shall recount a little of their future history. Distilled with oil of vitriol, the salt is decomposed and prussic acid formed, the most violent of all poisons—prussic acid made from woollen rags, pigs' toes, and blood! What more striking example of the wonderful transformations effected by chemistry! This acid, in a peculiar state of combination with iron, forms what is called ferro-prussic or ferro-cyanic acid, which, combined with potash, forms the yellow salt of which we are speaking; and which, although it may be said to contain prussic acid, is nevertheless quite innocuous. If, instead of distilling it with sulphuric acid, we fuse it at a bright red heat, the iron separates, and we get a white salt, containing prussic acid in combination with potash, and which is to a great extent poisonous. Thus, a little iron alone is sufficient to alter all the properties of this curious substance. The white salt obtained in this way is largely employed in preparing solutions of gold and silver for electro-plating; and the greater part of the silver and gold with which the various electro-plated articles in common use have

been coated, has existed at one period in combination with this white substance. Another use of this yellow salt is to produce prussian blue, which is formed by adding to a solution of it in water some sulphate of iron or green copperas, when the ferro-prussic acid will part company with the potash; the latter will unite with the sulphuric acid of the copperas, leaving the iron of the latter to unite with the ferro-prussic acid to form the prussian blue. This powder, sold at 1*s.* 6*d.* to 1*s.* 10*d.* a pound, has various uses; it is used as a paint, and to make thumb and button-blue for the laundress; it is used to colour confectionery, and by the Chinese, whom the Europeans have learned to imitate, to make green tea. But its principal use is in calico printing. When used for the latter purpose, however, the prussian blue is usually made in the cloth itself. If we thicken a solution of green copperas with gum or with flour, and print a particular pattern upon a piece of white cotton, and then pass it through a bath of the yellow salt dissolved in water, we shall obtain the pattern in prussian blue so much admired by ladies. In general, the beautiful dark blue dresses, with white patterns, are made by covering the whole of the calico with prussian blue, printing the pattern upon it with caustic soda, or potash thickened with pipeclay. The caustic substance decomposes the prussian blue, leaving the iron in the cloth as a buff pattern; but by washing in a bath of oxalic acid the iron is removed, and the pattern remains of a beautiful white. Thus may worthless woollen rags, and similar vile things, come back again to us; at one

time in our tea, while they may have assisted to make the spoon with which it is stirred; at another, as a brilliant coloured flower upon our room papers; or finally, as the colouring material of a lady's dress. Prussian blue was discovered in Berlin, hence the name, and was first made in Great Britain about eighty years ago. It was then sold at two guineas the pound; but the present average price, wholesale, is not more than 1*s.* 9*d.*, the finest sorts costing 3*s.* 6*d.* to 4*s.* per pound.

Prussiate of potash was not known in commerce, in a crystallized state, till about the year 1825, when it was sold at 5*s.* per pound, but at present it only costs 1*s.* 3*d.*; whilst the quantity made increased from 10 tons in 1825, to 1,040 tons in 1850. There are, I believe, twelve factories where it is at present made, which could produce about 20 tons per week, but the demand is very fluctuating, a matter not to be wondered at, if we recollect that its principal application depends entirely on the ever-varying taste of the ladies. We may estimate the annual value of all the prussiate of potash manufactured in Great Britain at about £150,000.*

## GELATINE AND GLUE.

The most refuse and uninviting, and seemingly worthless parts of animal bodies, are turned to uses of the most unexpected kind by the inventive skill and science of man.

* W. K. Sullivan, in Dublin Exhibition Reports.

The raw materials chiefly used in manufactures derived from the gelatinous textures of animal bodies may be divided, observes Professor Owen, as regards their commercial value and application, into two kinds:—

1st. The gelatines and glues, properly so called, derived from the dissolution of certain animal tissues, and especially from the waste residue of parts of animals, which have served for food, or for the operations of tanning, or for the fabrication, as from bone, of articles in imitation of ivory, or from the waste particles in the carving of ivory itself.

2nd. The cleansed and dried membranes of different species of fish, more especially of the sturgeon family, preserving a peculiar texture, on which their value in the refining of fermenting liquors more especially depends; such membranes are called isinglass.

The most remarkable progress in the economical extract and preparation of pure gelatines and glues from the waste remnants of the skins, bones, tendons, ligaments, and other gelatinous tissues of animals, has been made in France, where the well-organized and admirably arranged establishments for the slaughter of cattle, sheep, and horses in large towns, give great and valuable facilities for the economical application of all the waste parts of animal bodies. Mons. L. F. Grenet was the first to fabricate, on a large scale, out of various residues of animal bodies of little value, beautiful and diverse products, many of which previously had been derived from the more costly substance—isinglass. Among the numerous productions of this industry are different kinds of gelatine in

layers, adapted for the dressing of stuffs, and for gelatinous baths in the clarification of wines, which contain a sufficient quantity of tannin to precipitate the gelatine ; pure and white gelatine, cut into shreds, for the use of the confectioner ; very thin, white, and transparent sheets, called "papier glacé," or in paper for copying drawings ; and, finally, a quantity of objects of luxury or ornaments, formed of dyed, silvered, or gilt gelatine, adapted to a variety of purposes, and to the fabrication of artificial or fancy flowers. Many manufacturers in France have risen to great eminence in this line, by following the processes of M. Grenet.

Under the various names of glue-pieces, sizing, spetches, and scrows, the offal or parings of skins and hides, and the pelt from furriers, the hoofs and ears of horses, cattle, and sheep, are used by the glue-makers. Old leather scraps are even converted into glue. Gelatine is a purer kind of glue, also obtained from waste materials, such as the raspings and trimmings of ivory, the bones, cartilage, and tendons of animals. The clippings of parchment, vellum, gloves, leather, and other kinds of skin and membranes yield size. The French buy up largely our written parchments, and after removing the writing, return them to us in the shape of kid gloves. The shavings of seal and other skins are used for filling tennis and cricket balls.

## THE USES OF GUT, &c.

Bladders of oxen, pigs, calves, and sheep are prepared for holding lard, tying down bottles and jars, &c. Quantities are imported from North America and the Continent, packed in salt or pickle. Some of the gut forms cases for Bologna sausages, polonies, black puddings, preserved meats, &c., and gut constitutes also the material of that very important substance—gold-beater's skin, the manufacture and use of which are valuable trades in London. Under the misnomer of catgut and catlings, there is a very important application of a waste material in the manufacture of the dried twisted peritoneal coverings of the intestines of sheep, for the strings of musical instruments. These are imported to the value of £2,300 a year.

Catgut-cord is used for a variety of purposes where strength and tension are required, as for the strings of musical instruments, for suspending clock-weights, bow-strings for hatters' use, and for archers' bows.

The manufacture of musical strings requires a great amount of care and skill, both in the choice of materials and in the manufacturing processes, in order to obtain strings combining the two qualities of resistance to a given tension and sonority. Until the beginning of the last century, Italy had the entire monopoly of this trade, and they were imported under the names of harplings, catlings, lute-strings, &c.; but the trade is now carried out with more or less success in every part of Europe. However, in

the opinion of musicians, Naples still maintains the reputation of making the best small violin strings, because the Italian sheep, from their leanness, afford the most suitable material; it being a well-ascertained fact that the membranes of lean animals are much tougher than those of high condition. The smallest violin strings are formed by the union of three guts of a lamb (not over one year old), spun together.

The chief difficulty in this manufacture is, in finding guts having the qualities before mentioned—namely, to resist tension, and giving also good vibrating sounds. It is far more easy to arrive at the proper point in the making of harp, double-bass, and other musical strings, and the manufacturer is not so much circumscribed in the choice of the proper material. The tension upon the smallest string of the violin, which is made of only three guts, is nearly double that on the second string, formed by the reunion of six guts of the same size.

In the preparation, the sheep's guts, well washed and scoured, are steeped in a weak solution of carbonate of potash, and then scraped by means of a reed cut into the shape of a knife. This operation is repeated twice a day, and during three or four days, the guts being every time put into a fresh solution of carbonate of potash, prepared to the proper strength. In order to have good musical strings it is indispensable to avoid putrid fermentation; and as soon as the guts rise to the surface of the water, and bubbles of gas begin to be evolved from them, they are immediately spun.

In spinning, the guts are chosen according to their

size ; combined with three or more, according to the volume of the string required, they are fastened upon a frame, and then alternately put in connection with the spinning-wheel, and submitted to the required torsion. This operation performed, the strings, left upon the frame, are exposed for some hours to the vapour of sulphur, rubbed with a horse-hair glove, submitted to a new torsion, sulphured again, further rubbed, and dried.

The dried strings, rolled upon a cylinder and tied, are rubbed with fine olive oil, to which one per cent. of laurel oil has been previously added. The oil of laurel is supposed to keep the olive oil from becoming rancid.

The gut-strings employed by turners, grinders, and for cleaning cotton, &c., are made with the intestines of oxen, horses, and other animals. These, cleared by putrefaction of the mucous and peritoneal membranes, and treated by a solution of carbonate of potash, are cut into straps by means of a peculiar knife, and spun in the same way as the musical strings.

The uses of bladder and gut for holding lard, for covering gallipots and jars with preserves, as cases for sausages, polonies, &c., and other domestic purposes, are well known. Lately, however, the vegetable parchment, as it is termed (which is ordinary paper steeped in sulphuric acid), has come into extensive use for some of these purposes.

Insufflated, or inflated guts, are chiefly used for the preservation of alimentary food. These have to pass through a long series of modifications and processes before becoming fit for use. The end of these pre-

parations is, to free the muscular membrane of the intestine from the two other membranes covering it, the peritoneal and the mucous.

The first operation of scouring consists in freeing, by means of a knife, the gut from the grease attached to it, and also of the greatest part of the peritoneal membrane. The scoured guts are washed and turned inside out, then tied together, put into a vat without any more water than that adhering to them, and left in this state to undergo a putrid fermentation. The time required for this operation will be from five to eight days in winter, and two or three days only in summer. If the fermentation were pushed too far, the guts would be disorganised : to avoid this inconvenience, the workmen are often obliged to add some vinegar, in order to neutralise the ammoniacal compounds formed, and also because fermentation is slow in the presence of acids.

After this fermentation, the mucous membrane is completely decomposed, and the remaining portions of the peritoneal membrane are easily taken off. The guts are then well washed, and insufflated (inflated).

This operation is performed in the same way as swelling a bladder, with this difference, that the extremity of the gut is tied by a ligature serving also to join a new gut insufflated (inflated) in the same way. During this operation, the guts exhale the most noxous smell, and workmen employed at such work could not blow or insufflate many days in succession without having their health affected.

In order to prevent that inconvenient, unhealthy process of manufacture, the *Société d'Encouragement* of

Paris proposed a premium for a chemical process enabling the manufacturers of these articles to dispense with putrid fermentation. The process suggested by M. Labarraque, the successful candidate, is remarkable for its cheapness, and the facility of its application. In following the method recommended by this chemist, these animal matters can be worked more easily, and kept for a longer time without evolving any noxious smell.

The guts, previously scoured, are put into a vat containing, for every forty guts, four gallons of water, to which $1\frac{1}{2}$ pound of (*Eau de Javelle*) oxi-chloride of sodium, marking 13° on the areometer of Baumé, is added. After twelve hours of maceration, the mucous membrane is easily detached, and the guts are freed from any bad smell; by this method, the process of insufflation is more easily performed.

The insufflated guts are suspended in a dry room until the desiccation is complete; and, once dried, the extremities by which they were tied together are cut, and in pressing the hand over the length of the insufflated (inflated) gut, the air inside is completely taken out. The guts are then submitted to fumigation by sulphur, in order to bleach and to preserve them from the attacks of insects. After this last operation, the guts are fit for use. Besides our large home supply of bladders, we import several hundred thousand a year, packed in salt and pickle, from America and the Continent, and the aggregate value of the bladders used in this country is stated at £40,000 or £50,000.

The use of the reindeer-sinew for lashing or bind-

ing purposes on implements, &c., is common from Norway and Lapland, along the entire coast of Asia and America, even as low as 36° N. in California. and continued on the coast-line up to the easternmost point of America, and again at Greenland. Sir E. Belcher, in "Transactions of the Ethnological Society of London," states, he traced this custom of using the reindeer-sinews continuously on the western coast as far south as the thirty-sixth parallel on the coast of California, where the Mexican Indians soak it and form it into layers, in which they enclose the wood of the bow entirely. The horns of the bow are also moulded of it ; and, when dry, it presents the dull-grey translucent features of horn.

---

## BONES AND THEIR APPLICATIONS.

Bones are certainly a waste product, and are largely used for various purposes. Even the shank bones of the giraffe have recently been imported in some quantity from Southern Africa ; and elephants' bones in the East make an excellent ivory substitute. Ground bones, and dissolved bones, or superphosphate of lime, are in extensive demand as fertilizers, and superphosphate, as already shown, is manufactured from coprolites. It is the meanest of the bones that are ground up for phosphates and made fertilizers of the soil. Bones enter largely into commerce for manufacturing purposes, being employed by cutters, turners, and others, for making bone black or animal charcoal. They are converted into handles for tooth-brushes, nail-brushes, knives,

fans, combs, small spoons, buttons, and a score of other things. Bones are classed according to their value. Thus the thigh bones of bullocks are the most valuable. The jawbones come next, and the short bones, the refuse of the family table, are of the least importance.

Bones are boiled to obtain the gelatine for the size used by dyers and finishers of fustians, velveteens, &c., and to obtain the fat, which is white from fresh butchers' bones, and brown from imported and old collected bones. The colour is improved by this boiling. The bone waste, dust, and refuse is extensively used for manure.

We imported about 64,000 tons of bones in 1857, valued at £397,000; and 66,509 tons in 1861; and it is estimated that 70,000 tons are collected at home, worth about £350,000 more.

Assuming that the weight of an animal's skeleton is a twentieth of its entire carcase, and that the weekly consumption of beef, pork, and mutton in London, averages 10,000 tons, the question of, what becomes of the bones? is a little more puzzling than at first appears. It is a question, however, that concerns womenfolk rather than men, and womenfolk answer it. "It is easy enough to explain what becomes of the nasty things," says the mistress; "they are Betsy's perquisites." Betsy experiences no difficulty in advancing the inquiry another stage, and in a way equally lucid and satisfactory as her mistress.

"They goes to the rag-shop," says Betsy. So they do, O paragon of allwork! That, beyond dispute, is a phase of their career, whatever else may happen to

them. They may be hoarded by the thrifty, thrown into the dustbin by the improvident; they may come to the dogs, even; but to the rag-shop they are inevitably carried.

Who cares what becomes of them after that? With the "picking" of a bone its existence as an article of utility is popularly supposed to terminate. Nothing of the kind. Its career is, as it were, but just commenced; it had not even attained its proper growth till the day when it ceased to be a sheep's leg-bone and became a leg-of-mutton bone, and the basket into which Betsy casts it is not its coffin but its cradle. Don't despise the unwholesome, mildewed-looking thing should you by accident encounter it a month after it entertained you at dinner. You can't afford to despise it. You may meet it again under very different circumstances. In a gorgeous brown crackling coat it may yet grace your dining-table; you may be under obligations to it for the exquisite flavour of your next spring lamb. Bone manure is, of course, at the bottom of the secret.

A popular description of the operations carried on at a Lambeth bone-boiling factory, given lately in one of the illustrated journals, furnishes some curious particulars. Beyond the unpleasant smell there is stated to be nothing objectionable in a bone factory. Dr. Wynter informs us that men and women employed among the apparently pestilential heaps in dustyards enjoy even more than ordinarily good health; and that twenty tradesmen called promiscuously together, compared with twenty "sewer-flushers" (the reader has doubtless seen these fellows,

with high boots and big lanterns, who descend into the bowels of the city through iron-capped traps in the pavement), were found to be sounder and healthier as a body than the shopkeepers. In the case of the bone factory at Lambeth, we are describing, the proprietor for more than twenty years has lived and brought up a large family, in a house at the end of the yard, and surrounded on all sides by crushing sheds and boiling sheds and immense ranges of buildings, where the raw material is stored. Some years ago, when this factory-owner was indicted as the perpetrator of a public nuisance he triumphantly brought forward a blooming flock of big and little boys and girls, who had breathed the factory atmosphere from their birth. The workmen about the premises fare no worse than the resident proprietor. I have it from the lips of the men themselves—and many of them have laboured at the mills and boilers for ten and fifteen years—that illness is extremely rare amongst them, and that during the last terrible visitation of cholera—nowhere so destructive as in the low-lying parts of Lambeth and Vauxhall—not a single "hand" at the bone-mills was affected. Entering this factory we find the place paved with bones, walled with bones: there are mountains of them to the right and to the left, and breast-high they hedge avenues leading to the various departments. One of these departments is devoted to cookery. It is a long, low shed, and may be called the kitchen of the establishment. The cooking utensils are a row of immense coppers capable of containing, I am afraid to say how many gallons, and the cooks are big, hairy-armed men, in

heavy woollen frocks and coarse-sack aprons. Ladles and spoons are dispensed with, and their place supplied by pitchforks. As I stand at a respectful distance, and, peering through the rank mist that fills the kitchen, see the great cauldrons foaming, pitchy black, and their heavy lids heaving and stirring uneasily, I find my faith in the innocuous quality of the business flagging, — staunch Dr. Wynter even serving as an imperfect comforter. I am not reassured by the proprietor; for, says he, "Don't go closer; you may find the ammonia too much for you." Yet there were the cooks as contented and as cheerfully busy as bees in a hive.

Another department was the mill-room, where the bones, after their gelatine had been extracted in the boiling process, were reduced to atoms. Here there was nothing to offend the nose, for the material divested of its fatty matter is as innoxious as wood chips; but the ears suffer dreadfully. The mill is simply an arrangement of toothed iron rollers, among which the bones are swept by a man who stands by a sort of slanting stage above, on which the bones are heaped, and from which he scrapes them with an iron scraper. Nevertheless, the unfortunate particles of skeletons, in passing through the revolving teeth, emit a sound of crushing, and crunching, and grinding, impossible to anything but bones, and terribly suggestive of corporeal suffering, the extraction of firmly-bedded molars and incisors not to be forgotten.

The value of bones as a manure, although discovered more than a hundred years since, has only been taken full advantage of since about 1815, when bonemills were

established in Yorkshire. Previous to that, on farms where bone manure was used, the material was reduced to handy bits by the application of a hammer, or else it was strewn in the cart tracks to be crushed by the action of the wheels. How it is that the chief substance that enters into the composition of bone is good to fatten the land is easy of explanation. The principal chemical ingredient in bone is phosphate of lime —fifty-three in a hundred of its parts are so composed. Vegetable life is largely dependant on phosphates for its growth and maintenance; so largely, indeed, that should the soil become exhausted of that principle, the crops raised thereon are sickly and weak, and scarcely worth the harvesting. This was the case in Cheshire at the end of the last century, and was doubtless occasioned by the constant and long-continued drain of the soil of its phosphorus in the shape of corn and dairy produce. The rich red sandstone loams of the district were worn out—sucked dry, as farmers say. More by way of experiment than as a certain remedy, the exhausted pasture land was dressed with bone manure, at the rate of a ton to the acre, and in less than three years the value of the said land was doubled. The turnip hungers for phosphates more than any other vegetable. It has so small a seed that the quantity of phosphates stored round it for the nourishment of the roots and leaves of the young plant is in a poor soil by no means adequate to the demand; hence the necessity of concentrating by artificial means the vital element about the tiny seed, else those other essentials to turnip life —carbonic acid, water, and ammonia—may abound to

as little purpose as a windmill without wind. So it comes about that your discarded mutton bone of to-day nurses and comforts next spring's vegetation, and the ox eats thereof—the tender grass, the matured hay, and the juicy turnip—and waxes sturdy and stout of limb, and fat enough to be brought to market, and to be bought by Mr. Brisket, your butcher, who sends you a joint of the beast, and you are afforded an opportunity of renewing acquaintance with an old friend.

In 1839 Liebig suggested that the efficacy of bone-dust as a manure might be vastly increased if it were dissolved in sulphuric acid. A part of the Lambeth manufactory is set apart for this purpose. Here is sunk a deep pit containing a great iron tank, in which the mixing takes place; 15 cwt. of the acid being added to every ton of bone-dust. The result of the incorporation is a heavy, slate-coloured soft powder, worth from five to eight guineas per ton. As, however, the animal matter still remaining in the bone-dust is a hindrance to the blending of the acid with the earthy matter, there is mixed with it a considerable proportion of bone-*ash*, from which every particle of gelatinous matter has been extracted, and which materially assists the sulphuric acid in its action. Bone-ash is obtained by the complete combustion of bones in an open furnace, where the oxygen of the air burns away the organic matter, and leaves the earthy constituents as a white friable mass. If, on the other hand, the bone—say a shinbone—be immersed in an acid sufficiently diluted to prevent its injuring the animal membrane, and yet strong enough to dissolve the

phosphate of lime, the remaining matter will still retain the exact figure and dimensions of the original bone, and yet be rendered so flexible that it may be tied in a knot.

It must not be supposed, however, that all the bones that pass through the gates of the Lambeth factory are either ground or dissolved for manure. Some of them are much too valuable to be so used; as, for instance, the leg bones of the ox. I was shown tons of these with the knobs at the ends sawn off, some in cisterns sunk in the floors and still undergoing the bleaching process, and others stored in great barrels, as beautifully white as ivory. Large quantities of these are sent to France and other parts of Europe and converted into handles for tooth and shaving brushes, children's gum-rings, knife-handles, and cheap combs.

A considerable portion of the Lambeth boneworks is adapted to the manufacture of soap from the fatty material obtained from the bones. Did space permit, much interesting matter might be written concerning the various processes; of the coppers, broad and deep enough to drown a dozen men, and of the mysteries of "mottled," and "yellow," and "primrose," together with their comparative merits. One little bit of information that I gleaned concerning soap may be of value to the thrifty British matron, and she is heartily welcome to it. Beware of cheap soap, however proper its appearance may be. "This," said the worthy soapmaker, handling a "bar" of unexceptionable "yellow," "is as good as the article can be. This"—he took down another sample, seemingly of equal quality—"is cheaper by at least a third."

"Inferior material, of course." "Nothing of the sort, Sir! The same material exactly, with this difference—the cheaper sort (people *will* have cheapness, you know) contains a compensating amount of *water*. It is so full of it that it is a difficult matter to cut the great block into bars, but the bars are immediately subjected to such a heat as dries the outer surface and cakes it hard, giving it the sound and substantial appearance it now wears."

---

## EMPLOYMENT OF BLOOD.

How seldom is any attempt made to save the blood when animals are slaughtered in large cities and towns, on the farm, or by village butchers. Blood is, however, occasionally collected and sold to refiners of sugar and other classes of manufacturers. It is made into animal charcoal and albumen. Coagulated, it is bought by calico printers for dyeing, and in some of the agricultural districts it is esteemed as a fertilizer.

Some people use the blood of cattle largely as food, mixed with meal of one kind or another. When intended for this purpose it is stirred briskly as it flows from the veins, whereby its coagulation is prevented, and it is then stirred into the meal, and boiled or cooked in any other way. The coagulating property of blood renders it of considerable use in clarifying thick mucilaginous liquors.

Cider is sometimes fined by this method, being simply beat up cold with the blood and put into a barrel. On standing a day, the entire coagulation of the blood with the impurities of the cider, are found

lying at the bottom, in a tough cake, and the liquor above is quite transparent and nearly colourless.

Blood is collected by the butchers in two different ways, and sold thus :—1st, Stirred blood, *i.e.* agitated whilst cooling to prevent coagulation, is run into casks of about 100 gallons each, and sold to sugar refiners for clarifying, at about 20*s.* per cask.

2nd. Coagulated blood is put into casks, generally old molasses puncheons, and sold to calico-printers for dyeing "Turkey-red," and to chemical manufacturers for preparing red liquor for printers' use. The price is about 12*s.* to 14*s.* per cask of 80 gallons. The aggregate quantity thus used throughout the country has been estimated at 6,000 tons, realizing £4,000 ; the residue is thrown away with the straw as manure. Sheeps' and pigs' blood is used in making black puddings, a description of food much consumed by the poorer classes. The total weight of these made every year in the kingdom, at the very lowest computation, is 5,000 tons; and as they sell at 4½*d.* a lb., this brings up the aggregate sale value to £210,000.

---

## USEFUL APPLICATIONS OF OTHER WASTE ANIMAL SUBSTANCES.

BILE, the bitter principle secreted by the liver, has been occasionally employed with advantage in medicine, when dissolved in alcohol or inspissated. But its chief use out of the body is as a detergent to scour wool and cloth, remove grease spots, &c. Ox gall is chiefly applied to this purpose. It here seems to act as a kind of soap, but with superior powers as a deter-

gent than the mere quantity of alkali in it would indicate.

The same property of mixing with and dissolving oily matters renders bile serviceable to painters in various ways. When refined it is used by artists to fix chalk and pencil drawings before tinting them. Ivory, when rubbed with ox-gall, loses its greasy gloss, and is thereby much fitter to receive colours, and the gall itself is used to mix greens, bistre, and some colours where the greenish yellow of the gall is not perceived.

Neats-foot oil and trotter oil are products obtained in the process of boiling down calves'-feet and sheep's-feet; the former is used for softening leather and other purposes, the latter principally as a hair-oil.

We have long paid a tax on dogs in this country, but in Paris the imposition is new, and it led to an immense destruction of these quadrupeds in the Seine. A number of persons forthwith engaged in the occupation of getting out the dead bodies, and boiling them down to extract the fat, which is employed in the preparation of kid gloves, and especially of straw-coloured ones, being sold at the rate of 2½ francs per kilogramme (about 1*s.* per pound).

In New York, from 5,000 to 8,000 stray dogs are annually impounded, and those not redeemed are drowned. The carcases are taken to the offal-boats, which convey them to Barren Island, where every part of them is turned to some useful account. The fat is rendered out; the skins are sold to glovers; and of the bones an excellent compost for fertilizing land is made. Dogs' fat is very much used by the

Germans in the United States, the Cape, and other localities, in cases where cod-liver oil would be prescribed by our physicians.

Whether the dog is utilized to the same extent here I am not prepared to say, but we see a good many dog-skin gloves ticketed in the outfitters' windows, and as there are more than 400,000 dogs on which duty is paid, exclusive of fully as many thousand more in the country which do not pay the tax, there is scope enough for industry in this respect.

We have it from good authority that from 250 to 300 horses die weekly in the metropolis alone, within a radius of five miles from Charing-cross, and the whole of these (at least, the carcases) are consumed chiefly by dogs and cats in that area, supplying the barrow of that musical itinerant, whose cry is such a welcome sound to the members of the feline race,—"the cat's-meat man."

Now the aggregate value of a dead horse ranges from 20*s.* to 60*s.*, and the average value is therefore 40*s.* The weight of the whole carcase in pounds is from 672 lb. to 1,138 lb., the average being therefore 950 lb.

The weight of a horse necessarily varies with the breed, use to which it is put, condition, &c. Ordinary sized farm horses may weigh from 12 to 13 cwt. A colt belonging to the Carron Company weighed $18\frac{1}{4}$ cwt., whilst a splendid dray horse belonging to Messrs. Perkins & Co. weighs net 1 ton.

Now, what is done, or what can be done, with the various parts of the carcase after it has reached the knacker's yard, when old age or accident has terminated the career of this useful servant to man?

The following are the several applications of the parts of the carcase :—

Hair of mane and tail, 1½ lb., value 8*d.* to 1*s.* per lb. —used for hair-cloth, stuffing mattresses, and making bags for crushing seed in oil mills, &c.

Hide, 30 lb., about 8*s.*—tanned for leather, used for covering large office and board-room tables, &c.

Tendons, 6 lb.—for glue and gelatine.

Flesh, 224 lb.—boiled meat for men, dogs, and poultry.

Fat, 20 lb., 3*s.* 4*d.*—used for lamps, after distilling, and other purposes.

Intestines, 80 lb.—for covering sausages, making gut-strings, and the like.

Heart and tongue — a mystery ; most probably for human food.

Bones, 160 lb., 4*s.* 6*d.* per cwt.—for knife-handles, phosphorus, super-phosphate of lime.

Hoofs, 8*s.* to 10*s.* per cwt.—gelatine, prussiate, fancy snuff-boxes.

Shoes, 5 lb., 5*s.* to 10*s.* per cwt.—shoes again, and old iron.

More than a million of cattle are slaughtered every year in the River Plate countries, and the vast quantity of sun-dried meat of the animals is consumed only in two markets, the Havana and Brazil, where it constitutes the staple article of food for the slaves. Could some cheap and effective method, either by desiccation or otherwise, be introduced for the purpose of rendering this valuable and nutritious supply available for the white race at large, the results to the advantage of the Argentine Confederation would be invaluable. This article of export is well

worth the attention of European scientific and practical men.

*Slush* is a term applied to the skimmings of the coppers on board men-of-war; formerly this was the perquisite of the ship's cook, who was in the habit of collecting as much as possible, and disposing of it wherever he could find the best market. Ships' cooks in a line-of-battle-ship, with a complement of 1,000 men, usually made from £50 to £70 per annum by the sale of their slush; but in consequence of its having come to the knowledge of the Admiralty that the cooks were in the habit of over-boiling the men's meat for the purpose of extracting as much fat as possible, their Lordships very wisely put a stop to the cooks taking the slush at all, paying them as a compensation from 1*s.* 6*d.* to 6*d.* per diem, according to the rate of the ship in which they may be serving. Under the present regulation, the skimmings from the coppers are allowed to be appropriated (in kind only) for the use of the ship, a sufficient quantity being delivered to the boatswain from time to time for this purpose; the remainder is returned into store when practicable, otherwise it is disposed of, and the proceeds debited on the cash account of the paymasters.

On the old system, the amount of slush saved was generally calculated to be from 80 to 90 lb. every three months for 100 men. Under the present system it is much less; this is attributable to the cooks not taking the same interest in its preservation, consequent on their being paid a regular allowance.

It would be a curious investigation to follow out the

value of the street-sweepings, scavengers' collections, ashes, &c., obtained in this metropolis and other large towns, but the subject would carry me too much into detail, and I have not the figures as to the large sums paid to different districts for the contract or privilege of carting away the waste.

The corporation of Antwerp, which used to pay £1,000 a year to get rid of the refuse of their city, now receives upwards of £40,000 a year for the sweepings of the streets and the contents of the cesspools, contractors converting the nuisance into powerful guano. At Paris and Milan town guano is manufactured, which has extraordinary powers as a fertilizer.

The street-pickers and sewer-rakers, and the persons who frequent the river banks, &c., gather up rags, bones, metal, old boots and shoes,—in fact, anything that can be sold or reconverted to a useful purpose.

The boots and shoes go to the translators, vampers, and clobberers, as they are technically termed in Monmouth-street and the purlieus of Petticoat-lane and Rag-fair, where, by the use of heel-ball and clobber, a mixture of ground cinders and paste, the crevices and breaks of our old "understandings" are filled up; and, when the cement is dry and a few nails and stitches are added, they are polished and disposed of to those who patronize or can only afford cheap shoe-leather.

Various attempts have been made to use scraps of waste leather in the manufacture of articles for which pure leather has been employed; but the new products have generally failed to be serviceable where they were exposed to much wear, because they lacked

strength or tenacity. In some cases, other substances have been used in connection with waste leather. A device of this sort has been lately patented by Mr. T. Gee, of Nottingham, who uses hemp or flax fibre. His product is designed to be used for belting, uppers of shoes, &c. He first takes old boots and shoes, old harness, belts, &c., cuts them in small pieces, washes them thoroughly in water, and reduces them to a soft, pulpy condition by soaking. After this, he rolls them out between rollers, dries and mixes them with minute quantities of hemp or flax fibre. They are now immediately united together with a strong solution of glue or gutta percha, then rolled out into bands for belts, or pressed into moulds for the uppers of shoes, or other articles designed to be manufactured from it.

We import yearly about 20,000 cwts. of raw knubs or husks and waste of silk, valued at £17. 10*s.* to £18 per cwt. The husk which covers the chrysalis, after the best silk is reeled, is used for bed-covers, or spun for common silk stuffs. This offal amounts to ten per cent. of the weight of raw silk. When the gum has been discharged from the husks and knubs, these are bleached and the dressed waste cut to a uniform length for carding. It can then be twisted into skeins, rovings, and cops. The Chinese, not content with using up the silk thread of the cocoon, with their usual thriftiness, determining that nothing shall be wasted, eat up the chrysalis itself.

The walrus hide has been tanned for leather. In Texas, they even tan and prepare alligators' skins, so as to resemble the finest calf-skin in pliability,

and they are beautifully mottled, like tortoise-shell. Boots have been made of them, and it is certainly something novel to change the skins of these huge, ugly reptiles into forms of beauty and usefulness. We hope, also, to get musk from them some day. In the East and in Africa, they convert snake-skins into slippers, and use them, as we do shagreen, for giving a firm grip of the hand to the sword-hilt. Specimens of these, from Brazil, and from Siam, were shown at the International Exhibition; also iguana skins, used as coverings for scabbards, from Gaboon. The women of the Orotchys, Tungooses, and Goldians have the art of tanning or preparing the skin of some species of salmon, so as to be flexible, for the purposes of clothing, and it forms most of their dress.

All excrementitious deposits of animals are valuable as fertilizers of land, but those of the domesticated animals are of course most largely available.

The exuviæ of animals are of considerable use for several manufacturing purposes, as well as for fuel in some foreign countries. Horse-dung is used in making the cores or loose internal parts of the casting moulds for foundry purposes. Cow-dung is used in calico-printing, for fuel, and for moulding into children's ornaments in India. Dogs'-dung and pigeons'-dung are employed in the processes of tanning leather. Camels'-dung is largely used for making sal-ammoniac, in Egypt, and is moulded into cakes and sold for fuel in several countries. Guano, the dung of sea-fowls, and coprolites the fossil exuviæ of extinct animals, night-soil, &c., form important and valuable fertilizers of land.

Night-soil is sold as an article of commerce throughout the Chinese empire, in the form of cakes, mixed up with one-third of their weight of marl. Horse and other dung is also collected in the public roads and streets by the poor, and made up into cakes in the same way, which are dried in the sun.

Among the refuse of the farm premises none is more valuable than urine, 1,000 lb. of which ordinarily contain 65 lb. of the richest dry fertilizing matter. It is too generally allowed to escape, and the whole waste of the farm-yard and piggery are permitted to run off. It therefore happens that at least one-half of all the fertilizing matter contained in these animal productions is lost.

---

## THE UTILIZATION OF THE WASTE OF THE FISHERIES.

ATTENTION has frequently been directed to the substances wasted in the fisheries and returned to the sea as garbage, and to the detriment of the fisheries. The difficulty hitherto has been the collecting and bringing together the refuse to one or more conveniently-situated manufactory. The preparation of fish guano, that is to say, the transformation of the carcases and offal of fish into a manure adapted for restoring to cultivated soils their fertility, is a branch of industry which, I think, will in due time assume a remarkable extension.

The utilization of the waste products of the fisheries has often been discussed, and its importance acknowledged, but comparatively little progress has yet been

made in earrying out the subject on an extensive scale.

"Fish is spread to great advantage upon grounds, where it is to be had in plenty, and from being quickly consumed, may soonest be applied." In all towns upon the sea coast the refuse of fish may be obtained upon moderate terms. It is matter of surprise, therefore, that this hint of Evelyn, given in the year 1675, should have operated so little, that the use of refuse fish is extremely limited even at the present day. The sea, with generous bounty, throws at the feet of the husbandman her richest treasures, and invites him to partake with freedom, but instead of embraeing the proffered riches, he drives his team to some distant town, to purchase at a high rate what the watery elcment offers without a priee. It has been establishcd, that the rcfuse of herrings is equal to any other manure hitherto made use of, and it may be carried to a eonsiderable distanee from the eoast at little expense. The refusc of the herrings caught by one boat will, along with the dog-fish, on an average, be sufficient manure for two acres of land.

Fish in many parts of the world are employed as manure. On the sea eoast of the north-eastern American States, fish are so employed extensively. In New England, on the eoast of New Brunswick, and on the borders of Maine, mussels are gathered and ploughed in. In many parts of England sprats and other small fish are obtained in great quantities, and employed in the same manner. In the State of Connecticut, fish are presscd for the oil, and the cake is dried, and found to be exeeedingly fertilizing, eonsist-

ing of animal matter and bones, with a little oil remaining in it.

The fishermen on the American shores use damaged and frequently putrid fish as bait for mackerel. They are thrown into a box-hopper, in which a cylinder, studded with knives, is made to revolve by a crank. This is called the bait-mill, and by it the fish is reduced to a kind of paste, called pohagan; this is thrown into the sea to attract the fish, which are then caught by lines with hooks having a piece of polished pewter attached.

In Sweden, the mass remaining in the boiling pans, after subjecting the herrings to heat for the extraction of the oil, and known as trangrum, is used as a manure, either mixed with clay or with charred seaweed. In Norway, the solid resinous mass which remains after boiling cod-liver oil, and known as korg, grug or gras, is also used as manure when made into a compost with earth.

Mr. Braithwaite Poole, in his "Statistics of British Commerce," tells us that there are annually used in the United Kingdom 90,000,000 tons of farm-yard or animal manures, exclusive of guano, nitrate of soda, and other artificial fertilizers, involving a money value of £25,000,000. Anything that would economise the labour of transporting and spreading bulky farm-yard manure, by giving us a more concentrated and portable fertilizer for our soils—anything that will render us less dependent upon the Peruvian government for guano—must be hailed as a national boon. Although the utilization of the sewage of towns, of sea-weeds, and of the offal and inedible fish

of our coasts has been discussed for years past, they have not yet become articles of commerce, so as to be available to any extent by the agriculturists of the kingdom.

Professor Fownes says, "In every system of manuring, it is not the *name* of the manure, but its *chemical composition*, that constitutes its agricultural importance; the chief object is to restore to the land the substances which animals and crops have taken from it, and which cannot be restored by the atmosphere." Again, "the art of manuring land depends chiefly upon two considerations: first, a knowledge of the organic constituents of the crop intended to be grown; secondly, a knowledge of the constituents of the soil;—or, in other words, the soil must be able to supply the crop with mineral food, sufficient in kind and quantity to enable it to arrive at full maturity. Without this, a soil, however good, may be rendered perfectly sterile by carrying off crops every year."

Concentrated manure has ceased to be a novelty; the valuable properties of ammonia and phosphate and their varied application are now familiar to the agriculturist, and large sums are yearly expended in the United Kingdom to procure these desiderata. The annual importation of Peruvian guano, which stands foremost in public estimation, now exceeds 178,000 tons, realizing about £12 per ton. Fish being, to a certain extent, the source of this most valuable fertilizer, its manufacture into a manure has already led to some practical research; but, owing primarily to the neglect of economy in its reduction, and the complicated mechanical appliances experi-

mentally used therein, those efforts were not attended with commercial success. Mr. S. Osler, of Great Yarmouth, has patented a process whereby fish can be converted into a most valuable manure, by extracting the fluids and reducing the solids to a dry powder by simple and inexpensive means; the application of which, upon a scale commensurate to the largely increasing demand, will, to a great extent, render agriculturists independent of the Peruvian government. The following is condensed from a report by Professor Way (of the Royal Agricultural Society of England), on fish manure:—"It is perfectly practicable to produce from fish a portable manure of great value, not subject to alteration by keeping under ordinary circumstances. There cannot be a doubt of the value of this manure, especially for corn crops; and the manufacture of manure from fish offers the only available means of supplying the demand for additional ammoniacal manure, and will, if carried out on an adequate scale, be of essential benefit to the agriculture of this country."

Owing to its quick decomposition, fish has not been systematically applied as an agricultural stimulant, except in the immediate vicinity of a fishery; but it has been ascertained, by multiplied experiments upon a scale sufficiently large to afford satisfactory tests, that it may be cheaply converted into a dry, inodorous, and most valuable article of commerce, yielding to the land nutritive powers of a most permanent character; and that the application of capital to this portion of the trade alone will secure a most remunerative return.

Professor Liebig says, "A time will come, when plants growing upon a field will be supplied with their *appropriate* manures, prepared in chemical manufactories,—when a plant will receive only such substances as actually serve it for food." (*Vide Chemistry in its Application to Agriculture.*)

The progress of chemical science is every year affording additional light, both as to the *kind* and the *quality* of manure or food which must be supplied, and proving that no effort is likely to yield a richer reward to the farmer, than attention to the economy of manures; this subject is, in fact, pressing itself more and more every season upon the attention of the practical man.

Since the cessation of bounties, the fisheries have been declining; but a useful stimulus would undoubtedly improve them, and the manufacture of the superabundant fish would soon supply that stimulus. There is a want for more guano than Peru can supply, the demand is increased and the supply is falling off. All the new discoveries are phosphatic and not ammoniacal. A ton of guano is the equivalent of 10 quarters of wheat, a cargo of 1,000 tons to 10,000 quarters. In the United Kingdom we have usually under culture 5,000,000 acres with wheat. We import annually on the average about 5,000,000 quarters of wheat and flour. This is exactly one quarter per acre more than our home produce, and that quarter might be got.

Guano or huano, in the language of Central Peru, signifies manure, and is the excrement of the guano-birds which feed upon fish. It is the most valuable of known manures, on account of the ammonia and

phosphate which it contains, rendering its action immediate on the soil, and is found mostly between the fifteenth and twentieth degrees of south latitude. It is chiefly used by the Peruvians, in the culture of maize, &c., on their sandy plains, and may be traced back upwards of 500 years. The benefits enjoyed by the Peruvians from the use of guano may be seen in the work of Antonio di Ulloa, a Spanish author, who published his voyage to South America in 1748, and afterwards by the celebrated Von Humboldt, who further described its abundance, qualities, and use. Its formation refers to an era when the deluged globe was provided with a greater number of aquatic birds than at the present, and countless ages must have passed away before such accumulations could have taken place. Under the government of the Incas in Spanish Peru in the fifteenth century, it was made a crime, punishable by death, to destroy any of the sea fowl that inhabited the guano islands, indicating the high estimation in which the substance was held; and this throws light on the means of its accumulation.

It may be asked, why the manure from sea fowl, to be found in quantity on some of our northern rocky islets, should not equal foreign guano? This is fully accounted for by the humidity of our climate, the frequent rain washing away its most valuable properties; whereas in Peru it never rains, and the manure is deposited stratum on stratum, where it consolidates, dries, and retains all its powerful ammoniacal elements, which are especially required for the luxuriant growth of agricultural crops.

It is, therefore, confessedly an object of the first

importance to find an auxiliary, or substitute, for guano, which may check excessive prices, limit the increasing consumption, and afford a provision of artificial manure, if the supply of guano should fail. Fish, the source of guano, naturally suggests itself. The supply is inexhaustible, and almost unlimited. Reduced to its solid parts, it is a valuable concentrated manure, rich in the best fertilizers, ammonia and phosphates: while the gelatine and oil may be collected as merchantable products, which will generally pay the cost of converting the fish into manure, and perhaps leave a profit.

It has been ascertained by multiplied and satisfactory experiments, and confirmed by actual working, that the waste and refuse fish may be thus converted, and the gelatine and oil collected. The machinery and the process are most simple, inexpensive, and effectual. The resulting manure is a dry fibrous powder, which retains all the fertilizing powers of the fish in a form the most convenient for use, and whose appearance and sensible properties make adulteration almost impossible; since every one could judge for himself, by the mere inspection and smell, of its genuine character. The demand would certainly far exceed the utmost attainable supply; and at a price cheap as compared with any other manure, it would give a very large profit to the manufacturer. The waste and refuse of a great fishing port will furnish the materials cheaply and without risk or great outlay; and as it will be a great additional gain to a fishing adventure to obtain a certain and constant demand for all this waste and otherwise unsaleable fish, the

establishment of manufactories of fish manure would lead to new fisheries, where, without such aid, they could not prudently be commenced.

We are all aware of the extent to which the importation of guano has been carried on for years past, from Africa, South America, and other quarters, exceeding two millions sterling annually; and any substitute that could be found for this substance would confer a substantial benefit on the country, and give employment to a branch of industry deserving of encouragement. We have around our seaboard, a reservoir of similar products to those of the places named; and if, instead of trusting to the chemical agency of birds, we converted the fish which swarm upon our coasts into as profitable manure as they produce, it would materially assist our fisheries and confer an invaluable boon to agriculture. Owing to the facility of its decomposition and consequent difficulty of transport, it has heretofore been unemployed for this purpose, except on the coasts where it is found; but by a very simple patent process, it can be converted into a dry, inodorous, and easily transported article of commerce. Thus, fish carefully prepared without the loss of its elementary constituents will produce greater results than Peruvian guano, at a much less cost. In proportion as it becomes known that the introduction of fish guano into the fields of the farmers will put money in their pockets—or, what amounts to the same thing, prevent its going out,—they may be expected zealously to patronize it; and the skill and science once almost exclusively devoted to the production of one class of commodities will now

be brought to bear upon the cultivation of the soil.

Fish scales may be procured wherever there is a smoking-house, and would be a valuable addition to the manufacture on account of the ammonia and phosphates which they contain; these are similar to hair, horn, wool, and other appendages of the skin. The action of ammonia on such solids promotes their decomposition: their advantage is, that nothing is wasted; their defect, that they are slow—this they have in common with bone dust. Scales ground and mixed with fish manure will be quite as good as Peruvian guano, the fish powder would act quickly, the scales more slowly, but all would be good and no waste. The patent fish guano will have the animal fibre, the nitrogen of which will be converted to ammonia, when the manure decomposes on the ground, and this is its great excellence. It is not like guano which evolves ammonia with such intensity that it will kill vegetation unless diluted; this manure will not give any, for it has none, till it decomposes by moisture, by being put into the ground, and then the clay will absorb it as fast as it is evolved. Common care to keep it in a dry store will suffice, and if accident should wet it as on shipboard, it will take no harm for a few days, but may be redried, and will be then as good and safe as ever. The proportion of phosphate and azote will vary with different fish at different seasons. It is enough to fix all the manuring principles and remove all that is worthless for the purpose. The body of the fish is excellent. It contains much phosphorus, as we see by the shining of stale fish, abounds with ammonia;

and prepared in a form available for preservation, carriage, and distribution on the land, no manure can be better.

It is quite clear that no one spot and no one manufacture could supply the hundredth part of the demand; but it may be carried on wherever there is a cove to shelter a boat, and fishing ground to employ it. The manure would pay to support a fishery of itself, while the better fish will sell readily, the comfort of all the working classes be promoted, a nursery of the finest seamen be maintained; and help be everywhere at hand for distressed vessels, since the fishermen would be the best of pilots, and the best of crews for a life boat. None but a fisherman can tell the take of a trawler; the quantity of fish in the sea is illimitable, hence there are no bounds to the supply. It only depends on energy and the exercise of skill to afford any quantity that may be required. All the inhabitants of the ocean can be converted into guano. Nearly all except the best fish have hitherto been thrown away, the farmers declining to take the trouble to procure them, although quite ready to admit their good qualities. Skate, dog-fish, five-fingers, prawns, and small crustacea, may be converted into valuable manure; and a certain market for refuse and broken fish would be a great boon, and tend to the more perfect development of the fisheries. It is stated, that a cod produces more than three millions of eggs, a ling nine millions, and other fish several hundred thousands; and the question of supply would be set at rest for ever, were common industry, patience, and perseverance, employed in

securing this vast wealth that exists on our coasts. The most earnest and searching inquiry is, therefore, demanded in this matter; and the opportunity of improving the manuring facilities of the farming interest should not be foolishly neglected.

About 25*s.* per ton delivered, may be calculated upon as an average price for inedible fish throughout the year, although it is frequently to be bought in quantity at much lower rates; but, to insure a continuous supply, a sufficient motive must be given to induce fishermen to fish in all weathers. Much, however, will depend upon the tact displayed by the buyers; and no two stations will probably purchase fish upon precisely the same terms, but a higher rate at one would be balanced by the lower price at another. The great point is to get the men to work, giving them living prices; this hitherto has been the great drawback, for not having been remunerated for their toil and exposure, they have thrown the refuse fish away.

Many manure companies have started, but for want of practical men to carry out their designs they have failed. Large sums have been squandered in preliminary expenses, absorbing all their capital.

Ten tons of inedible, firm, fresh fish will produce nearly three tons of guano, and a similar quantity of salted about four tons; containing upwards of 20 per cent. of alkaline salts. After extracting the oil and gelatine which will partly pay the cost of manufacture, the refuse is valuable to gardeners and farmers as a liquid manure; this is chiefly a solution of gelatine, flavoured with osmazone (the principle which gives to

different meats their particular and distinguishing taste). The earthy portion in fish bones is less than in land animals, although the amount of phosphate in proportion to carbonate may be greater ; the precipitate we get by sulphuric acid is sulphate of lime or gypsum. The phosphates in fish guano may be rendered soluble by sulphuric acid, or by the action of caustic potass, and thus possibly increase the value of the manure, and the silicate of potass would be found excellent either for grass or corn.

In Ireland, a market for offal, damaged or inferior fish, is the great desideratum, and by establishing stations on the coast, any amount of supply could be secured, by paying a fair price per ton. Ireland's waters are rich mines of wealth, and the Irish fishermen are enterprising and industrious when encouraged and paid. Fish guano is the element of progress, and it will be found that those who most cultivate it will be in the ascendant, and wealth will flow in continuous and willing tributaries to purchase and reward it.

Cornwall is the chief seat of the pilchard fishery, and very large quantities of inedible fish may be obtained on that coast if properly sought after. The fleet of fishing boats take mackerel in the spring, then pilchards, and afterwards fill up the year with herrings on the Irish coast, all with drift nets, except the seans for pilchards.

Thus from a variety of sources might be produced a quantity of genuine manure, without waste, and which consists of the azote and phosphate principles of fish in their most concentrated and available form ;

the large amount of nitrogen present affording the most ready and simple test of its great value.

In a Report on Great Yarmouth, addressed to James Caird, Esq., M.P. for Dunbar, by Mr. Samuel Osler, he says :—

"We have a succession of fishing and need never be without fish, and provided there was a constant market, the take would be enormously increased. Dog-fish during the autumn fishing of three months (to use the fishermen's expression), 'are as plentiful as drops of water, many a yard long, and 28 lb. weight.' These are the natural enemies of nets and men, and are cut away from their lines and removed from their nets as quickly as possible. An unlimited number of these may be obtained at about 20*s.* per ton. They fish purposely for dogs at Cromer, and at various points on the Norfolk coast, and due encouragement would secure a very large supply.

"We have sixty trawlers belonging to two companies, sending in their prime fish daily; the inedible fish thrown overboard from these vessels exceeds 5 cwt. each, or 15 tons daily, making 90 tons per week, or 4,680 tons returned annually to the deep; this, at 20*s.* per ton,—a remunerative price,—would give the companies a large additional profit to be divided between them, at present wasted, besides the broken fish, of which no account is taken.

"Nearly four hundred vessels are employed in the herring and mackerel fishing, these produce during the autumn 2,000 to 3,000 tons of refuse fish and salt; and the numerous smoking-houses from 500 to 700 tons of herring scales, containing upwards of 16 per

cent. of nitrogen, and 40 per cent. of phosphates, together with the charcoal and waste; this will be, like bone-dust, a permanent manure.

"Sprats succeed the autumn fishing and are very abundant on the coast, they are bought from the boats on the fishing grounds at very low prices, in enormous quantities for manure, and chiefly used by the hop and cherry growers. The finest are selected for smoking, and sale among the poor. It is difficult to calculate the numbers of these, as they are very fluctuating. Immediately after the spring herrings make their appearance, many hundred tons of these may be bought at 25*s.* per ton; they contain no oil, and are only useful for manure. The mackerel and summer herrings follow, both highly valuable for their oil, about 17½ and 10 per cent.

"Our fishermen will only be too glad to fish for offal, numbers during summer are daily engaged in shrimping, and about one-half their take now wasted, consisting of hard-heads, needle-fish, and small crustacea, they would gladly sell at 3*d.* per basket, besides the refuse from our daily market. Proportionate quantities may be obtained at all the fishing stations from the unbounded supply afforded by the deep. 12,377 boats, manned by 43,014 fishermen, are at present employed, and 93,596 men and boys, including the curing department, and these will rapidly increase, providing a fair return can be made and their industry encouraged. Many hundred barrels of herring oil and livers are to be bought here, which would be an additional source of profit, including the manufacture of fish glue, of such

great use in lustring ribbons, gauze, and clarifying wines, &c."

ANALYSIS OF GENUINE FISH GUANO.

| | Dog Fish & Herring. | Offal Fish. |
|---|---|---|
| Moisture .. .. .. .. | 8·75 | 9·62 |
| Nitrogenous animal matter .. | 65·24 | 64·72 |
| Oil and fatty matter .. .. | 9·22 | 8·84 |
| Phosphate of lime .. .. | 9·24 | 8·86 |
| Sulphate of lime .. .. | 1·94 | 1·46 |
| Alkaline sulphates, and muriates | 4·58 | 3·10 |
| Sand, &c. .. .. .. | 1·03 | 3·40 |
| | 100· | 100· |
| Nitrogen .. .. | 8·99 | 9·24 |
| Equal to ammonia . | 10·92 | 11·22 |

A patent has been secured for combining in a cheap and portable form, all the nutritive portions of fish, for food, well adapted to support, efficiently and permanently, mental and physical vigour; it is easily preserved in all climates, seasons, and circumstances, in a form the most concentrated and convenient for carriage; it is prepared with little trouble, and by its cheapness accommodates itself to universal use.

The following announcement affords a practical exemplification of the demand for waste products of the fisheries :—

"To Fish-merchants and others.—Wanted, Dog and Refuse Fish, at 20*s.* per ton. Herring Scales (clean), at 4*s.* per swill of 2 cwt.,* and contracts for

* The swill is a fish-basket, or measure, which will contain about five long hundred (660) of herrings; twenty of these baskets making a last.

12 months agreed to. Livers, in barrels (including casks), at 16*s*., delivered at the Marshes, and paid for on delivery, by Samuel Osler, Patent Fish Manure Works, Great Yarmouth.—Smack-owners are respectfully invited to preserve their inedible fish, now thrown overboard, for joint benefit of themselves and men. Beachmen allowed 1*s*. per ton for collection."

Another attempt to carry out the manufacture of the waste from the fisheries has just been made (June, 1862) by the establishment of the North Sea Fish-Guano Company in London, which, having a practical board of directors, may probably be able to benefit agriculture by collecting in sufficient quantities the refuse fish of the North Sea, for economical conversion into dried or prepared manure. The manure as prepared by Professor Way, one of the directors of the Company and late consulting chemist to the Royal Agricultural Society, according to the analysis of Professor Voelcker, contains—

| | |
|---|---|
| Moisture .. .. .. .. .. | 6·07 |
| Organic matter* and ammoniacal salts.. | 64·95 |
| Phosphates of lime and magnesia .. | 24·01 |
| Carbonate and sulphate of lime .. | 1·52 |
| Alkaline salts .. .. .. .. | 3·03 |
| Sand .. .. .. .. .. | 0·42 |
| | 100·00 |

A few years ago, the Governor of Newfoundland drew the attention of the Royal Agricultural Society of England to the value and importance of the use of waste fish and fish-offal as manure, after having undergone a certain process of preparation for the purpose

* Containing nitrogen 9·13 equal to ammonia 11·09.

of rendering it portable to any distance, and of facilitating its application to the soil. His Excellency's letter covered a communication from Lieutenant Gautier, a French naval officer on that station. Governor Hamilton states :—

"In this island (Newfoundland) the manure universally applied to the soil is fish, consisting of the superabundant herrings and caplins in the process of decomposition, and generally without any earthy admixture ; and the heads, bones, and entrails of cod-fish, after having been decomposed and formed into a compost with clay or peat-bog earth.

"This manure, I learn, has, on trial and comparison, been found to be much more fertilizing than guano ; and when applied to the thin, gravelly, unpromising soil in the neighbourhood of this town, yields crops of grass and potatoes which, in vigour of growth and productiveness, cannot be surpassed elsewhere. It is no less powerful when applied to oats, which, however, owing to the shortness of the season and the consequent uncertainty of the ripening of the grain, are but partially cultivated here.

"Still, however rich and fertilizing as a manure fish-offal may be, when applied to the soil in even the crude state and unscientific manner in which it is used in this island, it could never become an article of export, and be made useful for agricultural purposes elsewhere, without undergoing a process of manufacture similar to that described by M. Gautier. In this latter condition it will be seen, from the analysis referred to in the accompanying paper, that it forms

a product perfectly analogous to, and at least as rich as, if not richer than, the best Peruvian guanos.

"Should further experience confirm the evidence of these results, there is no doubt that this island could supply a vast amount of the manure in question, affording at the same time an additional valuable article of export from the colony. There are many parts of the island and its dependencies from whence the fishing is extensively prosecuted, and where there is little or no agriculture, in which the manufacture of manure from the offal of fish at present thrown away as valueless might be extensively and advantageously conducted. The carcases of seals, which are now abandoned and left upon the ice—the skins and fat only of these animals being taken on board the sealing vessels—might also, in the event of the failure of the main object of the voyage, be made available in the furtherance of the manufacture in question."

It appears that about two-thirds, say one-half, the cod-fish caught is thrown away as waste or offal; so that out of 100 tons of fresh fish you have 50 tons for curing, reduced to 25 tons when dried, and 50 tons of offal. In the three years ending 1859 there were on an average upwards of 1,200,000 quintals of dried fish exported from Newfoundland, equal, at 20 quintals to a ton, to about 600,000 tons of cured fish. The offal from these, at the calculation of 1 ton to 5, ought to give about 25,000 tons of fish-manure, in a perfectly dried state, from cod refuse alone, at present available. As little or no value is set upon it at present, it may be estimated at little more than the price of collection, which, however, would be considerable.

There are no less than 367 vessels, of from 70 to 180 tons, amounting to 35,760 tons, and carrying 13,000 men, engaged in the seal oil and skin trade alone at Newfoundland. About the 1st of March this fleet proceeds to sea, and falls in with what is called the "sealing or whelping ice," where the seals breed and rear their young, sometimes on the coast of Labrador, and at others on the shores of Newfoundland itself; and after killing the seals, they strip off the skins and blubber under the skin, and, abandoning the carcases, they stow them in the hold. The voyage lasts about a month or six weeks on an average, according to the locality where they fall in with the seals, and sometimes ships return fully loaded in a week or a fortnight, while at others the voyage is a total failure. In 1857, there were 596,000 seals killed, from which 7,165 tons of oil were extracted, amounting to £265,131 sterling, and seal-skins to the value of £99,217 sterling, exported. The bodies of these seals, which constitute their chief bulk, must have given 50,000 tons, at least, of animal matter. In addition to these sources of the raw material, the seas and bays round Newfoundland abound with fish of every kind, particularly the caplin, as it is called, a species of small sprat, upon which the cod-fish live, together with the dog-fish, and others which are peculiarly rich in oil, and can be taken in great quantities by the slightest exertion, or the adoption of improved machinery and system. The chief difficulty to a successful manufacture is the want of labour, which is dearer at certain seasons in Newfoundland and more scarce than anywhere else, as there are

122,000 inhabitants in the island, and they are so exclusively occupied in the fishing and sealing seasons, in summer and spring, that they cannot attend to anything else. Governor Hamilton, in his excellent report, most judiciously remarks, that, unfortunately, in that colony there is little or no employment for the labouring population during the long period which intervenes between the close of the cod-fishery in summer and the commencement of the seal-fishery in spring, and that in the mode and processes of conducting the fisheries themselves, there is a great want of economy and a disregard for improvements which the application of modern science would suggest, and which might be rendered available in advancing the industrial pursuits of the colony. In conclusion, he says that "there are few parts of the world where the process of converting labour into capital is so speedy, or, for the extent of it, so efficacious, as at Newfoundland. If the catch of seals be an average one, upwards of £300,000 is realized from these 'sealing meadows,' as they are called, in a few weeks. The sea in this brief season yields a harvest more profitable than the plain, and without the labours of a seed-time, too." He also remarks that, since the abandonment of the deep-sea fishery on the banks, the cod-fishery is now confined to small boats on the coast and in the bays and harbours, and could hardly be carried on without the aid of the seal-fishery. But how vastly would the whole community be benefited by utilising the entire of the produce of both fisheries, in the combined manufactures in question. It is evident that the manufacture cannot be

carried on effectively and profitably either at Newfoundland or elsewhere, except by commanding the raw material to an indefinite amount and at a nominal price, or the price of collecting it. In the cases mentioned, large quantities are now procured for other objects, and wasted; and it is well worthy of consideration how far the increased demand for the article, and the enterprising spirit combined with the science and machinery of the present day, might not have the effect of establishing a new and profitable trade in Newfoundland, and of utilising the whole animal supply, and of combining the present curing of cod-fish, and the cod-liver and other oil trades, directly with the manufacture of manure from the refuse. But to effect this, it is evident that the capital, machinery, and skill must be chiefly supplied from this country.

M. Gautier says, "The result of the first attempts at such a manufacture, in 1851, yielded, on analysis:—

| | |
|---|---|
| Nitrogen, per cent. .. .. .. | (12·00) |
| Moisture .. .. .. .. | 1·00 |
| Nitrogenous organic matter .. .. | 80·00 |
| Soluble salts, viz., common salt, carb. ammonia, and a trace of sulphate .. | 4·50 |
| Phosphate of lime and magnesia .. | 14·10 |
| Carbonate of lime .. .. .. | 0·06 |
| Silica .. .. .. .. .. | 0·02 |
| Magnesia and loss .. .. .. | 0·32 |
| | 100 |

"It remains to inquire where and how are to be procured any large quantities of fish, or the remains of fish; and how they can be converted into powder?

Now we know, from the experience of our fisheries, that 400 tons of fresh cod do not yield more than 120 tons of dried fish for exportation. The refuse of the fish, which constitutes about half its weight, is often thrown away (in curing) into the sea. The bones are cast back by the sea on the beach, where they form considerable heaps, accumulated for centuries. Without reckoning upon herrings and other fish caught for the purpose, let us only consider the quantity of refuse at our disposal. The produce of the cod fisheries on the banks of Newfoundland amounts annually to about 700,000 quintals, of which 350,000 are cured, and the remainder rejected. If these 350,000 quintals were decomposed, pressed, dried, and pulverized, they would produce 100,000 quintals of a powder similar to the best guano, composed according to the analysis above given.

The pulverization requires drying stoves and machinery for grinding the bones. No attempt can be more worthy of encouragement, though time is required to judge its commercial result.

For many years past, M. Molon, a French gentleman, farming land in the department of Ille and Vilaine, has made use of fish for manure. For the purpose of diminishing the bulk of the manure, and of obtaining as concentrated a substance as possible, his plan is to dry the fish, and reduce it to powder. The following method is that which several years' experience has shown to be the best :—The fish is first disintegrated in a copper with double walls, by the action of steam of several atmospheres of pressure, introduced between the walls. After the water and

oil contained in the fish have been allowed to run off, the residue is submitted to considerable pressure, and the cakes thus obtained are then rasped down. The broken fish is next spread in thin layers on canvass stretchers, which are placed in stoves constructed for the purpose, and are there exposed to currents of hot air. The process of drying is by this means quickly completed, and as the dried fish is taken from the stoves it is ground to powder in a mill. When pulverized the manure is ready for immediate use, but may be kept for any length of time. Analysis and experience both show that the powder possesses all the properties of a good manure. Large quantities have now for several years been used by the French farmers, and the result has always been superior to that obtained from Peruvian guano. The oil derived from the fish is saleable, and the price obtained for it enables the manufacturer to deliver the manure to the farmer at a rate sufficiently low for agricultural purposes.

An extensive business is done in the vicinity of Narragansett Bay, Rhode Island, in the manufacture of fish guano. It is prepared in two ways: one by chemically treating, cooking, drying and grinding the fish. This is put in bags and sold at £5 per ton. The other kind is prepared in the same manner as the above, with the exception of drying and grinding. it is then combined with an absorbent which is considered a good fertilizer, and is sold at about 8s. per barrel, containing about 200 lb. The compost is of great strength, and is composed chiefly of simple flesh and bones of fish.

An analysis of the guano, made by Dr. Charles T. Jackson, of Boston, reports it to be similar to Peruvian guano in composition, with the exception that the ammonial matter is dried flesh of fish, and not putrefied, so as to be ammoniacal. It will, however, produce ammonia by decomposition in the soil.

The fishery at the Lofoden Islands, Norway, has been gradually increasing during the last 20 years, and, in 1860, 24,000,000 of cod, of the average weight of 200 fish to the ton, were caught. In the Findmarken fisheries, further northward, still larger quantities have been taken, and instances have been known of the catch being so immense that the fish themselves have been thrown away, from want of buyers, after the extraction of the liver for the oil. As the catch from the Lofoden fishery alone is equal in weight to 120,000 tons, there would be 60,000 tons of refuse, capable of producing from 15,000 to 20,000 tons of dry manure fit for the market, irrespective of the Findmarken fisheries, as well as the immense quantities of other kinds of fish suitable for manure.

Another instance of a useful fertilizer competing with the guano trade may be mentioned, the "Ulmate of ammonia," recently brought forward. Derived from wool, it yields, on decomposition, a large proportion of ammonia; and it appears to be exceedingly useful in the manufacture of home-made mixtures, particularly for application to corn crops.

A soap, which is represented to be without smell and of good quality, is made out of fish or blubber. The manufacturer boils it for some hours, then lets the contents in the boiler settle, and takes all but the

deposit at the bottom, which is thrown out and composted to make manure. He then strains the liquor through a coarse bag, which is put into a press, and all the loose matter pressed out. That which is left in the bag, after this operation, is put into the soap-kettle, with one-fourth its weight of tallow, and boiled with caustic, soda, or potash for seven hours.

Fishery salt is one of our most valuable alkalies: it fertilizes the land, improves all sorts of corn, is a remedy for rust and mildew in wheat, prevents disease in potatoes, and tends materially to destroy the slug, grub, and wire-worm. It gives greater quantity and better quality to all grain crops, strengthening the straw, producing heavier and brighter samples, assisting to ripen barley earlier, and increasing its yield; rendering oats more prolific, and its straw white and brittle, and is essential to the healthy condition of all live stock. It is one of the best means of preventing the ravages of the fly, and produces on rough pastures a much finer herbage, and sheep and cattle uniformly prefer it. Salt may invariably be used to great advantage upon light, dry, and loamy soils, at the rate of from 3 to 10 cwt. per acre, the quantity increasing with the lightness of the soil. In no case should salt be used on stiff clay, or cold wet land, till it has been properly drained, excepting when mixed with other manures. For wheat salt should be sown about 4 to 5 cwt. per acre on heavy land, and from 6 to 7 cwt. per acre on light, in equal quantities, spring and autumn. For barley, about 6 cwt. per acre on light soils, containing vegetable matter, will be found most valuable, and as a top dressing to wheat crops; by

sowing broadcast, 3 to 4 cwt. per acre after sunset for the destruction of the wire-worm and slug, taking great care that no portion of the land has a double share.

---

## MOCK PEARLS.

PEARLS can be so closely imitated as to defy detection, and a French jeweller, at the Exhibition of 1862, placed in his case alternate rows of large real and artificial pearls, with the query attached, "Which are the artificial?"

It is difficult to determine accurately at what period the false pearls were first made. There is reason to suppose that some kind of imitation of them was made as early as the thirteenth century, as we learn from the rules of the corporation of goldsmiths of Paris, for the year 1260; it is probable, however, that the imitations then made were simply opalescent glass beads, like those now made of different colours, under the name of *perles à la lune.*

About the middle of the seventeenth century, the mode of making artificial pearls by coating glass globules on the outside with a varnish made with the scales of a kind of fish appears to have been discovered. According to a book published in Paris in 1691, called "Livres des Addresses," the manufacture of these pearls, which are described as perfectly natural, was a new invention. The invention of these imitations is usually attributed to Jaquin, a rosary-maker. The process followed at present is to coat them on the inside instead of on the outside. For

this purpose a number of hollow beads of thin, transparent, cut glass are blown with a lamp, and a drop of the pearl essence is blown into it, and spread about by rolling them. The pearl essence is obtained by scraping the scales off the bleak, or *Cyprinus alburnus*, a fresh-water fish, and repeatedly washing them with water, until the whole of the foreign and animal matter is removed. When fully washed, a little solution of sal-ammoniac is added, to prevent putrefaction from occurring, and the essence is ready for use. In using it, however, it is found advisable to add a little isinglass, so as to make the varnish adhere well; a minute trace of carmine, saffron, or Paris blue is also added, in order to communicate a reddish, yellowish, or bluish tinge, in imitation of those shades observed in fine pearls. Formerly the makers of artificial pearls had to purchase the fish themselves in order to prepare the essence; but this has now become an article of trade, and a good deal of it is prepared at Eberbach, on the Neckar, for the Paris and Swiss pearl makers. It is calculated that 7 lb. of fish scales will yield 1 lb. of moist pearl essence, for which 20,000 fish would be required. The scales of the well-known white bait are said to surpass those of the bleak for artificial pearl making. The scales of the roach and dace have also been used for inferior kinds of false pearls. When necklaces were much worn in England, there was a considerable trade in false pearls in London, and fish scales were in such demand that from one guinea to five guineas were paid for a quart of them.*

* See an article in the *Technologist*, vol. i. p. 150, on the manufacture of mock pearls.

The very pretty and durable ornaments now made from fish-scales, by Mr. Mahood, are a new and attractive application of a waste substance; fish-scale brooches, bracelets, &c., are well known, and to be met with in the galleries of the Crystal Palace, the bazaars, and other places. The strong scales of many fish are well adapted for this purpose, such as the pearly scales of the corvino (*Sparus chilensis*), the golden scales of the kingfish, those of the callipeva, and the large scales of the pirarucu of Brazil. Fishes' eyes are also utilized by the manufacturer of shell flowers for imitating the undeveloped buds.

The natives of the north-west coast of America make from the entrails of fishes, bracelets, fishing-lines, thread, work-bags, head-dresses, and needle-cases; of the bones they also form fish-hooks and needles. But our more civilized brethren on the other side of the Atlantic have turned fish-bones to another purpose; they boil, cleanse, and shred them, and pass them off as isinglass, although scarcely containing a particle of the gelatinous property.

Dog-fish are caught principally for the oil obtained from their livers, a large fish yielding about a barrel of oil. Their dried bodies are sold in Nova Scotia, at 2*s.* 6*d.* the hundred, for feeding pigs during the winter, from November till May; two fish boiled or roasted are given per day to a good-sized store pig.

Several hundred dog-fish skins are annually imported, principally for smoothing wood and metals by their rough abrading surface. Eel skins are used in America and other quarters for twisting into ropes and whip lashes, and to form the thongs connecting

the swiple and hand-staff of the thrashing-flail. Sole skins, and some other fish skins, are sold in large quantities by fish salemen to dealers at 4½*d.* a lb., being used to refine liquors, clear coffee, &c.

---

## COLLECTION OF AND COMMERCE IN ICE.

Ice, a waste product of Nature, is an indispensable article of consumption in most countries, but especially is it appreciated in warm climates. The use of it to cool our beverage, or to preserve our food, is but one of its applications, and yet the extent to which it is used for these purposes is scarcely appreciated. In our short winters, there is the greater eagerness manifested to obtain and store up in cellars the ice obtained from the ponds and rivers in the neighbourhood of large towns, and laden carts may be seen wending their way to the great depôts of the confectioners or wine merchants very soon after a sharp frost.

But this is only one of the employments of this great auxiliary of life's enjoyment. By means of a plentiful supply of ice, we are able, under the highest temperature, to obtain an artificial climate adapted to our convenience and comfort. A building in the Southern States may be cooled in summer at no greater expense than it can be heated in winter, and just as easily; with an atmosphere out of doors of 90° Fah. we may regale ourselves in a temperature in-doors of 70°, paying for coldness no more than is done for fuel in winter. Then, again, its remedial uses regarded medicinally—to dispel malaria; its application for cooling

beverages, or, in large quantities, externally; to generate, in hospitals, depôts, and soldiers' quarters, and institutions of every kind, a cool atmosphere under high natural temperatures; to render the atmosphere of dwellings incompatible with the existence of the thousand noxious insects incident to hot climates: all these advantages and many more will suggest themselves as resulting from the transit of ice in such quantities and at such prices as to make it an available commodity for the supply of the wants of communities where Nature has not furnished the element.

With us, ice does not form a very large item of trade; besides our small home supply, we import from 10,000 to 32,000 tons annually (according to the severity or mildness of our winter), valued at £1 per ton. But in other countries, especially in America and Russia, they calculate the prospects of the ice crop as we debate about the state of our wheat crop. The value of the ice shipped annually from the American republic averages £300,000. The home consumption in the States is considerable, by almost all classes, who are accustomed to contract for a daily supply from those who make a business of selling it.

The Romans derive their supplies from stores of snow preserved in the caverns of Etna. The Chilians draw large supplies from the Cordilleras, and cheap ice is as much a necessity in Lima and Valparaiso as cheap bread is with us. And what is more singular, is, that amid all their revolutionary disturbances, ice-laden mules are never molested by either party. The Chinese appreciate the luxury of ice. In the East

and West Indies, the detention of an ice-laden ship is one of the greatest calamities that can occur. The ice consumed in St. Petersburg during the summer costs the inhabitants about £400,000.

This singular carrying trade from America to various countries was first commenced about half a century ago by an enterprising Yankee merchant, named Tudor, who shipped a cargo of ice from Boston to Martinique, and though the consignment resulted in a very heavy loss, it was carried on to other islands of the West Indies until the last war temporarily suspended it. Mr. Tudor, the originator, followed it up, however, subsequently, and the result was more profitable, leading to very extended transactions, having a contract with the Spanish Government to supply Havana, and also large and profitable demands at Charleston, Savannah, and New Orleans. In 1833, he extended the trade to the capitals of three Indian presidencies—Calcutta, Madras, and Bombay—and now several thousand tons are shipped monthly during the season to each of these places.

American ice is also forwarded to Pernambuco and Rio, to Mauritius and Réunion, and as far east as Batavia, Hong Kong, and Whampoa.

A few years ago, we used to be chiefly dependent ourselves upon America for a large quantity of Wenham Lake ice, which came to Liverpool; but of late years, the Ice-King has been more lavish in his home supplies, so that we have become more independent of foreign sources for the raw material for our wine-coolers and ice-creams.

The collection and sale of ice in America has

grown into an important trade, both for home use and for foreign customers. The domestic consumption of ice in the chief cities of the United States is estimated to amount annually to—

| | Tons. |
|---|---|
| New York .. .. .. .. | 300,000 |
| Philadelphia .. .. .. .. | 200,000 |
| Boston .. .. .. .. .. | 60,000 |
| Baltimore .. .. .. .. | 45,000 |
| New Orleans .. .. .. .. | 40,000 |
| St. Louis .. .. .. .. | 25,000 |
| Cincinnati .. .. .. .. | 25,000 |
| Washington .. .. .. .. | 20,000 |
| Mobile .. .. .. .. .. | 15,000 |
| Charleston .. .. .. .. | 15,000 |

In the vicinity of New York a large quantity of ice is obtained. There are several companies there devoted to ice cutting, storing, and vending. The amounts placed in storage during the winter of 1857 were as follows :—

| | Tons. |
|---|---|
| Knickerbocker Co. .. .. .. | 250,000 |
| New York and Brooklyn Co. .. .. | 40,000 |
| People's .. .. .. .. .. | 20,000 |
| Independent .. .. .. .. | 20,000 |
| Passaic .. .. .. .. .. | 10,000 |
| Total .. | 340,000 |

The first-named company cut and stored about 130,000 tons at Rockland Lake and employed upwards of 1,500 men. At High Lake and some other pieces of water, 50,000 or 60,000 tons more were obtained. New York exports but little ice, the supply required for home consumption occupying the

labour of the various companies almost exclusively. Large quantities of ice are also cut in New Hampshire, Maine, New Bedford, Providence, Baltimore, and Philadelphia.

The City of Boston is the chief port of exportation. The amount shipped each season now exceeds 200,000 tons, two-thirds of which are sent to the Southern cities, and the greater part of the remainder to South American and West Indian ports.

The trade is very advantageous to all concerned, and even benefits the timber men and saw-mills of Maine and New Brunswick. So much saw-dust is required in packing ice for shipment, that it sells for three dollars a load, and one or two schooners are constantly employed in bringing it from the saw-mills on the St. John river to Boston.

There are now sixteen companies in Boston engaged in the business of shipping ice to the East and West Indies, and to New Orleans and other southern ports. The demand for the article is now so great for export, that large contracts are made for it in Worcester county to be transported to Boston by railroad. They formerly sold their ice in New Orleans at six cents a pound, but now sell it at one cent; and where they made one dollar by selling it at six cents, they now make four dollars by selling it at one cent a pound. When it sold at six cents a pound, none but the wealthy could afford to purchase, but at one cent all classes buy it, so that it is sold before much of it is wasted by melting. The ice is sawed by a machine into square blocks not less than twelve inches thick, and is packed on board the vessels with straw and

hay, boxed with thin timber made air tight. One of the Boston companies paid last year 7,000 dollars for the straw and hay they used for packing.

Among those who have been most foremost in the commencement and prosecution of this trade in the products drawn from the domain of the Frost King, none have been more ardent and enterprising, or better acquainted with the details of the business, than Nathaniel J. Wyeth, of Fresh-pond, Cambridge. From that beautiful pond, abounding as it does with the pure and pellucid element, has been drawn the principal portion of the ice that has not only yielded its cooling influence to the inhabitants of the American cities and towns, but has blessed, with its refreshing luxury, some of the most distant portions of the globe.

In perambulating the borders of that beautiful pond, one might almost imagine himself back into the days of antiquity—and fancy this formidable building a temple reared in honour of the deity that presides over the lake. As he saw hundreds of men removing the masses of ice, he might suppose them votaries of that deity, endeavouring to release her from the fierce and iron embrace of the rude monster who was attempting to bind her down; and he might well suppose them engaged in some enthusiastic effort to let the sunlight in upon the beautiful bosom of the lake that was the object of their love and veneration.

A description of Mr. Wyeth's mammoth ice-house, upon the borders of Fresh-pond, may not be uninteresting.

The main building is composed of a triple wall, forty feet high, one hundred and seventy-eight feet

wide, and one hundred and ninety-nine feet long—enclosing more than three-fourths of an acre of land, and capable of containing upwards of thirty-nine thousand tons of ice. The walls are of brick, and measure four feet from the outside of the outer wall to the inside of the inner one; the intermediate wall, between the two, thus forming two air spaces. All three are connected by thin transverse brick walls, from the outside wall to the middle, and from that to the inner one. To prevent heat passing through them, they are so placed that no one of them is continuous through. Those which form the connection of the middle and outer walls, are intermediate between those which connect the middle with the inner one; thus forming, as it were, overlapping flues from the bottom to the top of the building. These flues, or air spaces, are again cut off by connections between the walls, laid horizontally. Here the same rule of never connecting the outer with the middle wall, at the same place as the middle is connected with the inner one, is again observed. These last connections are of plank, resting on projections in the brick work. About fifteen hundred thousand bricks, and eight hundred thousand feet of boards and other lumber, have been used in its construction. There are five receiving doors, opening into as many vaults, into which the building is divided. All the blocks of ice are of equal dimensions—and each vault is of such capacity as to contain an exact number of them, without any loss of room in the stowage. The whole is covered with five roofs, which are supported by the

outside walls, and the partition walls which separate the vaults. There is one discharging door, through which the ice contained in the vaults is to be placed on the railroad cars. To facilitate this operation, there is a lowering machine capable of sustaining three tons at one load. This machine is first worked at the door of the outer vault, and when the contents of that are exhausted, it is passed across to the next one, where it performs the same office, and so on. The floor of the house is brought to a level lower than that of the lake. The sides and bottom are water-tight. Immediately before the time of storing the ice has arrived, enough water is admitted to cover the floor, which freezes, and forms a perfect level on which to commence packing the ice. The outside of the house is in a good style of architecture. Its immense walls are relieved by pilasters, entablatures, covings, and other projections, so as to avoid the blank appearance it would otherwise present.

To the main building is joined a tool-house, one hundred and seventy-eight feet long, and sixteen feet wide, in which the whole apparatus of the ice trade may be seen at one view—each tool in its place, and properly registered. A division of this building is appropriated to workmen who repair the various machines, and to the grinding of tools, which last is done by horse-power.

There is another building, ninety feet long and seventeen and a half feet wide, through which the ice passes on its road to the rail-road cars, when transported from the lake without being stored. Besides

these, there is also a car-house, in which to store the rail-road cars (which are built for the establishment), when not in use.

If these buildings are remarkable for their size and adaptation to the purposes for which they are intended, the means of filling and discharging them are still more so. Seven rail-road cars can be laden with twenty-eight tons of ice in four and a half minutes, and unladen in one minute and a half, which may serve to show their excellence.

The following description will give an idea of the mode of operation :—The ice-houses, near the lakes and ponds, are immense wooden buildings, capable of holding 10,000 to 20,000 tons each ; some cover half an acre of ground. They are built with double walls—that is, with an inner wall all round, two feet from the outer one ; and the space between is filled with saw-dust—a non-conductor—making a solid wall, impervious to heat and air, and of ten feet in thickness. The machines employed for cutting the ice are very beautiful, and the work is done by men and horses in the following manner :—The ice that is intended to be cut is kept clear of snow, as soon as it is sufficiently thick to bear the weight of the men and horses to be employed, which it will do at six inches ; and the snow is kept scraped from it until it is thick enough to cut. A piece of ice is cleared of two acres in extent, which, at a foot thick, will give about 2,000 tons. By keeping the snow off it freezes thicker, as the frost is freely allowed to penetrate. When the time of cutting arrives, the men commence upon one of these pieces, by getting a straight line through the centre

each way. A small hand-plough is pushed along the line, until the groove is about a quarter of an inch in width, and three inches deep, when they commence with the "marker"—an implement drawn by two horses, which makes two new grooves parallel with the first, twenty-one inches, the gauge remaining in the first groove. It is then shifted to the outside groove, and makes two more. The same operation goes on, in parallel rectangular lines, until the ice is all marked out into squares of twenty-one inches. In the meanwhile, the plough is following in these grooves, drawn by a single horse, a man leading it ; and he cuts up the ice to a depth of six inches. The outer blocks are then sawn out, and iron bars are used in splitting them. These bars are like a spade, of a wedge form. In dropping them into the grooves the ice splits off, and a very slight blow is sufficient to separate them ; and they split easy or hard, according to the weather in a very cold day. Ice is very brittle in keen frost ; in comparatively softer weather, it is more ductile and resistible. Platforms, or low tables, are placed near the opening made in the ice, with an iron slide reaching from them into the water ; and a man stands on each side with an ice-hook, very much like a boat-hook, but made of steel, with fine sharp points. With these the ice is hooked with a jerk that throws it on the platform on the sides, which are of the same height. On a cold day everything becomes covered with ice, and the blocks are each sent spinning along, although they weigh two cwt., as if they weighed only a pound. The slides are large lattice-work platforms to allow the ice to drain, and three tons can thus be easily run in

one of them by one horse. It is then carried to the ice-houses, discharged upon a platform in front of the doors, and hoisted into the building by a horse. Forty men and twelve horses will cut and stow away 400 tons a day. If the weather be favourable, one hundred men are sometimes employed at once; and in three weeks the ice-crop, about 200,000 tons, is secured. Some winters it is very difficult to secure it, as a rain or thaw may come that will destroy the labour of weeks, and render the ice unfit for market; and then it may snow and rain upon that, before those employed have time to clear it off; and if the latter freezes, the result is *snow-ice*, which is of no value, and has to be planed off. The operation of planing proceeds in nearly the same manner as that of cutting. A plane gauged to run in the grooves made by the "marker," and which will shave the ice to a depth of three inches at one cut, is drawn by a horse, until the whole piece is regularly planed over. The chips are then scraped off. If the ice is not then clear, the work is continued until the pure ice is reached, and a few nights of hard frost will make it as thick below—inch for inch—for what has been taken off above. The ice is transported on railways. Each ice-house has a branch railway from the main line. It is conveyed in properly constructed box-waggons to Boston—a distance of (as the locality may be) ten to eighteen miles. The tools, machinery, &c., employed, and the building the houses, and constructing and keeping up the railroads, &c., are very expensive; yet the facilities are such, through good management, that ice can be furnished at a very trifling cost per pound; and a

failure of the ice crop in America would be a great calamity.

The walls of some of the ice-houses are filled in with tan and bark, and the ice is covered with wood shavings, the air is also excluded by stout doors to prevent waste previous to shipment. The ice season seldom lasts longer than three weeks or a month, and during that period the greatest activity prevails. The ice is weighed before shipment, and the weight so ascertained is that charged to the party to whom it is shipped. To prevent any dispute between the parties legally engaged in the trade, the ponds and lakes are mapped out and subdivided, and the particular locality of each person's occupation is strictly defined by law.

Boston, always the first in the market with its "notions," has now a serious competitor in Philadelphia in this branch of commerce. On the River Schuykill the ice usually attains a thickness of twelve or more inches, and is probably unrivalled in the purity of its composition and freedom from foreign and deleterious substances. Its colour varies from snowy opaqueness to translucency, and sometimes to the most beautiful watery transparency. Ice is formed in layers resembling what we see when a tree is cut down denoting the gradual growth of the tree. In ice 15 inches thick there will be formed twenty-one layers, and so on in that proportion.

Vessels freighted with ice always obtain a return cargo, and thereby a judicious exchange of local commodities is effected with points where, under other circumstances, the trade would probably be less extensive.

In Paris the consumption of ice is very large, and in England it is on the increase, when a sufficient supply can be obtained at a reasonable price. Its prime cost being merely nominal, and dependant on the mere outlay for labour and cartage, the profit must necessarily be very considerable. Hence pastrycooks, innkeepers, fishmongers, and others, endeavour in the winter season to store their ice vaults with such a supply as shall carry them through the summer.

The consideration of this branch of our subject serves to show that no article is so trifling as to be altogether useless, and that the trade even in frozen water is a most important one, and attended with large profits to those engaged in it. Besides the labour and capital employed in the ice trade, many vessels obtain entire cargoes of it. One Boston firm freights more than 100 vessels in a season with ice, and a cargo shipped to the East Indies has been exchanged pound for pound for cotton.

The single item of sawdust for packing it for shipment or voyages of any length, renders another substance valuable and profitable, which was formerly mere refuse, obstructing the streams into which it was thrown from the saw mills.

Therefore, separate from its frost pictures and pleasurable associations of sliding, skating, and curling, ice has its commercial uses and money value, and forms an important item of American export and consumption, which may read us a lesson of the various uses to which many neglected substances around us might be applied, and for which a remunerative market can be found elsewhere, if not at home.

Before passing from the consideration of ice, I may note a new use of snow pointed out in an American paper—"All places where snow abounds are not, perhaps, aware of the value of the fleecy flakes in making light, delicious, and wholesome bread. There is no 'rising' in the world so perfectly physiological as good, fresh, sweet snow; it raises bread or cakes as beautifully as the best of yeast, or the purest acids and alkalies, while it leaves no taint or fermentation like the former, nor injurious neutral salt like the latter."

It is not improbable that the muriatic acid so incessantly wasted in our soda works may be used for purifying glass-makers' sand; at ordinary temperatures this would probably remove the oxide of iron, which imparts the green tinge to common glass, and it certainly would by the application of a little heat.

Attention has been drawn recently by Messrs. J. Townsend and J. Mather, to the utilization of the residues from the manufacture of soda and potash. The uses to which the hyposulphates and sulphates are proposed to be applied are—first, as antichlorines in the manufacture of paper, and the treatment of cotton and other tissues, after bleaching by chlorine and its combinations; secondly, as agents for bleaching wool and other animal products, also for straw, starch, oils, ivory, horn, hair, &c.; and thirdly, as a purifier and antiseptic in the manufacture of sugar.

Bromine is an elementary substance discovered in 1826 by Balard, of Montpellier, in the bittern or residual liquid left after the evaporation and crystal-

lization of the salt from sea water. It occurs in small quantity also in most mineral waters, in many sea plants and sea animals, in some land plants, and in some minerals—especially the argentiferous ores of Mexico. In medicine, bromine is used for the same purposes as iodine, appearing to have the same therapeutical effects, and even greater activity. It is employed to some extent in photography, and has also been used in the form of bromide of potassium for the purpose of falsifying iodide of potassium. By the ordinary process of manufacture, two pounds and eight ounces of bromine are obtained from thirty gallons of the bittern. So much bromine is there in the western waters of America, that it will ultimately become a large manufacture where a sufficient demand shall have been created for this substance, which is sure to happen sooner or later, as new and important uses will inevitably be found for a substance of chemical characters and relations so peculiar and striking as those of bromine.

---

## WASTE MINERAL SUBSTANCES.

Finally, I must add a few words on miscellaneous mineral substances.

Professor Crace Calvert, in a valuable paper (in the *Journal of Society of Arts*, Vol. iii., p. 17), went into the various new or residual products of coal, exclusive of coal gas, such as, firstly, the coke, next the liquid portion, which is bought by chemical manufacturers, who obtain from it sulphate of ammonia for agricul-

tural purposes; and sal-ammoniac for soldering which is also used in calico and print works for producing the style of prints called "steam goods." And from these two salts is obtained hartshorn, extensively employed in pharmacy. Ordinary coal gas liquid is also often employed to obtain by distillation common ammonia, much used in dye works, and to produce with lichens the beautiful colouring matters called orchil and cudbear. Many hundreds of thousands of gallons of ammoniacal liquor are used in the preparation of ammoniacal alum. To obtain this and other refuse products of coal, aluminous shale comes largely into use.

Coal tar (of which about 300,000 tons are made yearly) furnishes a chief ingredient of printers' ink, in the shape of lamp black; it is also made into asphalt for pavements, and mixed with red-hot clay becomes a charcoal that acts as a powerful disinfectant; with coal-dust it forms, by pressure, an excellent and compact artificial fuel.

Carbolic acid possesses extraordinary antiseptic properties, and carbazotic acid gives magnificent straw-coloured yellow dyes on silk and woollen fabrics.

Crude naphtha, used for burning, benzine or benzole for removing grease spots, the heavy paraffin oil, extensively employed as a lubricator in the cotton mills, &c., are other commercial products, formerly waste or unapplied.

We may thus sum up the useful products of coal. They are, first, the refuse of combustion, such as ashes, clinker, soot, all of which are valuable for the making of roads, mortar, and manure. Secondly, products after distillation in the manufacture of gas, consisting

of light carburetted hydrogen, olefiant gas, the chief source of illumination; hydrogen, carbonic oxide, which impairs the luminosity; nitrogen, vapours of volatile hydrocarbons, and vapour of bisulphide of carbon, remarkable for its high refracting power, its great volatility, and highly solvent action on phosphorus, &c. Thirdly, matters separated by the condensation and purification of gas, as carbonic acid, sulphuretted hydrogen, hydrocyanic or prussic acid, sulphate of ammonia, chloride of ammonium, sulphide of ammonium, tar, and volatile oils. In connection with coal tar, we have coarse soaps and paints, as well as asphalte pavements. Further, by distillation at low heat, we obtain naphtha (not mineral properly so called), benzol or benzine Collas, benzoic acid, isomeric with hydrosalicylic, and oil of meadow sweet, benzoin, isomeric with oil of bitter almonds, nitro-benzol, smelling of the last, cyanide of benzoyle smelling like oil of cinnamon, formobenzoic acid, like oil of hawthorn, benzoyle, like oil of geranium. Then follow toluol, radicle of the balsam of tolu, cymol, base of oil of cinnamon, and a whole allied progeny. If the distillation be conducted at a higher temperature, we have paraffin oil, and petrolene, now so extensively coming into use. In addition to these, naphthalin in solid crystals, whose derivative, chloronaphthalic acid, produces beautifully-coloured compounds with the metallic oxides, and is nearly identical with alizarine, the basis of the madder dyes. We obtain, further, from the oleaginous results, the acid principle phenol, or carbolic acid, creosote, or phenyl-alchol, nitrophenesic, or picric acid, used in

dyeing, and producing salts of yellow or orange hues. Next come alkaline volatile principles, as picoline, leucoline, aniline. The latter, a thin oily liquid, may be obtained either from indigo or nitrobenzol, and indigo may be reproduced from it in turn. It has assumed immense importance from its application in the production of the favourite colour called *mauve*, which has had such a run of public favour of late. To obtain the colour, equivalent proportions of sulphate of aniline and bichromate of potash are dissolved in water, and the black precipitate filtered off. Dry and digest in coal tar naphtha, to remove a resin, and dissolve out the colouring matter in alcohol.

An immense amount of coal is wasted at coal mines by the process of breaking up the coal into the proper sizes for market. In this operation a large per centage of the coal is finely pulverised, and is thrown aside as unsaleable. This fine and wasted coal is of the purest quality. A correspondent of the *New York World*, writing from the Pennsylvania coal mines, states that at a single colliery doing a good business, four hundred tons of coal per day are made to pass through the machines for breaking up the lumps, and the waste is about 20 per cent., or eighty tons daily. All this amount has to be mined, brought to the breaker (two iron cylinders, with iron teeth, revolving in a horizontal position, paralleled to each other, and about ten inches apart), and, after this process of destruction, has to be carried away and piled up. One will see at any colliery, of several years' standing, hundreds of thousands of this now worthless article, very pyramids. All this, except what little is made

in the mines by blasting, has to be paid for by the operator, and is a loss to the owner of the land, as well as to the human family, and adds price to that which the consumer buys in the market. The waste at the collieries in Schuykill and Luzerne counties, Pennsylvania, is believed to be over one million tons annually, worth £1,000,000.

A small kind of coal called Burgie is used in this country for burning in engines.

Coal dust or slack ground in a mill is manufactured in the districts of Manchester, Wigan, Rainhill, &c., and used by ironfounders exclusively for the mould. Burgie, the dust coal of the mines, and screenings from house coal, is in Wales and other parts pressed into cakes of artificial fuel.

Warlich's patent fuel consists of bricks made by compressing with an hydraulic press, dust of coal rendered coherent by bituminous matter, and partly charred. These bricks measure 9 by 6½ and 5 inches, are dense, and require breaking before using. They burn with but little smoke, and form an excellent fuel, particularly where economy of room is an object, as it can be stowed very compactly. In many collieries no important use has yet been made of the dust coal. By similar treatment every pound of it might be saved, with a good profit to the manufacturer.

The ashes and small cinders sifted from the ash-pits and dust-holes are used for making bricks.

Soot, again, is largely collected, and sold by the chimney-sweepers at 6*d.* a bushel for transmission into the country as manure.

Of argol, the sediment of wine vats and casks, we

import now about 1,000 tons. When purified, it is denominated cream of tartar, and is much used by dyers as a mordant, to prepare the stuffs to receive their colours. About 1,000 tons of cream of tartar are also imported.

Glass bottles are always a saleable article at the bottle warehouses and the rag shops, wine and soda-water bottles fetching about 9*d.* to 1*s.* a dozen, and doctors' bottles 3*d.* a dozen. Flint glass is also saleable, being worked up again; and I am informed that there are from 1,000 to 1,200 tons of broken glass bought and used up annually in the few glass-works of the metropolis alone.

Here is an advertisement from the *Dental Review*, which shows that there is a demand for the sweepings of precious metals :—

"To Surgeon Dentists.—Messrs. Selim, Dean, & Co., beg to inform Surgeon Dentists that they Purchase Floor and Board Sweep, for which a Liberal Price is given. — Parcels from the country will meet with prompt attention. 9, Coventry-street, Haymarket."

Jewellers' sweeps is a general name for the scraps and dust remaining in silversmiths and jewellers' workshops, gold pen manufactories, &c., which are bought by persons who smelt it over again to separate the gold and silver from the refuse. Even the clothing, waistcoats, jackets, &c., of gold beaters and other workers in the precious metals are eagerly bought up for the recovery of the fragments accumulated in them, and I have heard of fabulous prices given for an old waistcoat that had been long worn

by a gold beater. At any time they can readily obtain a new waistcoat for their old one.

A New York correspondent narrates the following incident: "Calling in at the publishing house of Harper and Brothers this morning, I was not a little surprised at a fact that transpired during my chat with one of the firm. The foreman of their bindery, Mr. Rosenquest, who has for some thirty years filled that position, came in with a bar of gold valued at 307½ dollars, accompanied with the assayer's certificate. This amount was the proceeds of gold dust swept up from the floor and wiped off on the rags used by binders during three months. I was so much surprised at this bit of economy, that I asked what the value of their picked-up things amounted to in the course of the year, and was told that the gold sweepings were worth about 1,500 dollars, shavings from paper, 5,000 dollars; shavings from pasteboard, 700 dollars; and scraps from leather, 150 dollars—making an aggregate from these four sources of 7,850 dollars (£1,570) per annum."

Horse-shoe nails, kicked about the world by horses innumerable, are not the useless fragments we might naturally deem them. Gun-makers tell us that no iron is so well fitted for their purpose as that which is derived from horse-shoe nails and similar worn fragments. The nails are, in the first instance, made of good sound iron, and the violent concussions they receive when a horse is walking over a stony road, give a peculiar annealing and toughening to the metal, highly beneficial to its subsequent use for gun-barrels.

The scrap iron from needle-making and other manufactures is also sold by cart-loads, for making gun-barrels, as it is the finest-tempered steel.

The waste metal in cutting up steel pens, at Birmingham, is returned to the Sheffield steel converter, to be worked up again, an allowance being made for it of £10 per ton, the original cost being £50 or £60 per ton.

Steel-filings are sought for by the chemist to make steel wine. Barrels of brass-filings are also saved at Birmingham, fetching about half the original cost of the metal.

Old copper from ships' bottoms, copper bolts, &c., are always very saleable for reconversion.

In the manufacture of tin-ware, there is a large waste of the raw material in the shape of clippings and pieces, and as this waste consists of the two useful metals iron and tin, attempts have been made from time to time to reclaim each metal separately, with a view to utilize them. The tin, which demands, from its great value, the highest consideration, is first separated from the iron by an acid, and afterwards, by chemical means, restored to the metallic state, but the difficulty has been hitherto to keep the restored tin quite free from iron—the presence of which, though in minute quantities, effectually neutralizes the most valuable property of the tin. The great bulk of these clippings, however, is iron, which, by the process of heating and melting, can be re-formed into bars; and as a large proportion of the tin plates used in the manufacture of tin-ware, is composed of charcoal iron, a very fair quality of

bar iron might with care be produced, but this can only be accomplished by the introduction of hammers into the furnace itself, whilst the iron clippings are hot, as from their slight substance they would not retain sufficient heat, if withdrawn, for the hammering process in the ordinary way. The subject is evidently worth attention, as many hundred tons of tin clippings must be produced annually in this country, the make of tin plates exceeding 600,000 tons, and the exports having trebled in the last ten years.

There are about six or seven pounds of tin to every 100 of clippings, so that in 100 tons of this refuse material we should obtain, say, between five and six tons of tin, and perhaps 90 tons of iron. The loss from dirt is comparatively trifling, as the clippings are almost invariably quite new and clean. The clippings, I believe, are likewise used as a flux in the smelting of antimony ores.

Scrap iron, the cuttings and parings of iron work, are collected and melted again in the puddling furnaces.

Any one visiting the docks will occasionally see barge-loads of old iron being shipped as dunnage or ballast in vessels bound for the United States or for the Continent. It comprises a heterogeneous collection of all descriptions of articles, frying-pans and gridirons, saucepans and candlesticks, tea-trays and boilers, shovels and old corrugated roofing, and many are the jokes of the men who bundle in this old iron. It is the accumulated produce of the old-iron shops, the collection of the "mud-larks" of the rivers and

other itinerants. In 1857 we exported 36,500 tons of old and broken iron, chiefly to the Continent.

There is a greyish powder produced by the solution of sugar of lead in vinegar, which consists almost entirely of silver in a state of very minute division, and which, with other chemical refuse, formerly wasted, is now applied to useful purposes.

The shells from the shell banks on parts of the Chillian coast are collected by men employed for the purpose, and are purchased by the copper smelters, to burn into lime for mortar, as well probably as for a flux in their smelting operations. These shells also furnish the lime that is so much used by the Chilians for whitewashing their houses. Shell-lime, mixed up with ground dinas brick and salt-water, makes a most durable kind of mortar for that climate ; so firm does it set, that on knocking down an old wall, the stones will often break rather than the mortar. Shell-lime is also largely used in India for various purposes, especially as an ingredient in the betel-nut masticatory.

These, then, are a few instances of the utilization of waste substances. They can be of course but a tithe of those comprehended in so wide a subject. Some of them are amusing, many instructive exemplifications of the profit to be derived from the collection and utilization or re-application of waste and residual products.

# INDEX.

THE END.



ROBERT HARDWICKE, PRINTER, 192, PICCADILLY, W.

## British Ferns,

A Plain and Easy Account of. Together with their Classification, Arrangement of Genera, Structure and Functions, Directions for Out-door and In-door Cultivation, &c. By Mrs. LANKESTER. Fully Illustrated, price 4s. coloured by hand; 2s. 6d. plain.

## A Manual of Structural Botany.

For the use of Classes, Schools, and Private Students. By M. C. COOKE, Author of "The Seven Sisters of Sleep," &c. Illustrated by 215 Woodcuts, price 1s.; bound in cloth, 1s. 6d.

## A Manual of Botanical Terms.

For the use of Classes, Schools, and Private Students. By M. C. COOKE, Author of "A Manual of Structural Botany," &c. Fcap. 8vo, with more than 300 illustrations, price 2s. 6d.

## Old Bones;

Or, Notes for Young Naturalists. By the Rev. W. SYMONDS, Rector of Pendock. With numerous engravings. Fcap. 8vo, cloth, 2s. 6d.

## The Shilling Peerage;

## The Shilling Baronetage;

## The Shilling Knightage; and

## The Shilling House of Commons.

By E. WALFORD, M.A., Balliol College, Oxford. New Edition for 1862, just published.

## Wild Flowers worth Notice;

Being a Selection from the British Flora of some of our Native Plants, which are most attractive from their beauty, uses, or associations. By Mrs. LANKESTER. Illustrated by J. E. Sowerby. 96 illustrations, coloured by hand, price 4s.; uncoloured, 2s. 6d.

## The Foot and its Covering.

With Dr. Camper's work on "The Best Form of Shoe," translated from the German. By JAMES DOWIE. Fcap. 8vo, cloth, illustrated, price 2s. 6d.

## The British Fungi,

A Plain and Easy Account of, with special reference to the Esculent and other Economic Species. By M. C. COOKE. With Coloured Plates of 40 Species. Fcap. 8vo, price 6s.

## A Manual of Geography;

Being a Description of the Natural Features, Climate, and Productions of the various Regions of the Earth. By F. MORTON, C.E. Fcap. 8vo, 192 pp. complete, price 6d.

---

LONDON: ROBERT HARDWICKE, 192, PICCADILLY, W